ISSN 0916-7978

PB99-153033

Vol. 26 No.3 June, 1998

NEW TECHNOLOGY JAPAN

INNOVATIVE PRODUCTION NOW

Advanced Mass Production Lines for Plastic Package Substrates to Cope with Multi-Client Demands - Gama Plant of Ibiden Co., Ltd. -

NATIONAL R&D PROJECTS

Optical Tomographic Imaging System

GENERIC TECHNOLOGY REVIEW

Studies of Simple Synthesis of Organic Compounds by Active Catalysts

HIGH-TECH INFORMATION

Commercialization of Optical Control Material Indispensable for Optical Data Communications

Enzyme to Efficiently Decompose Formaldehyde

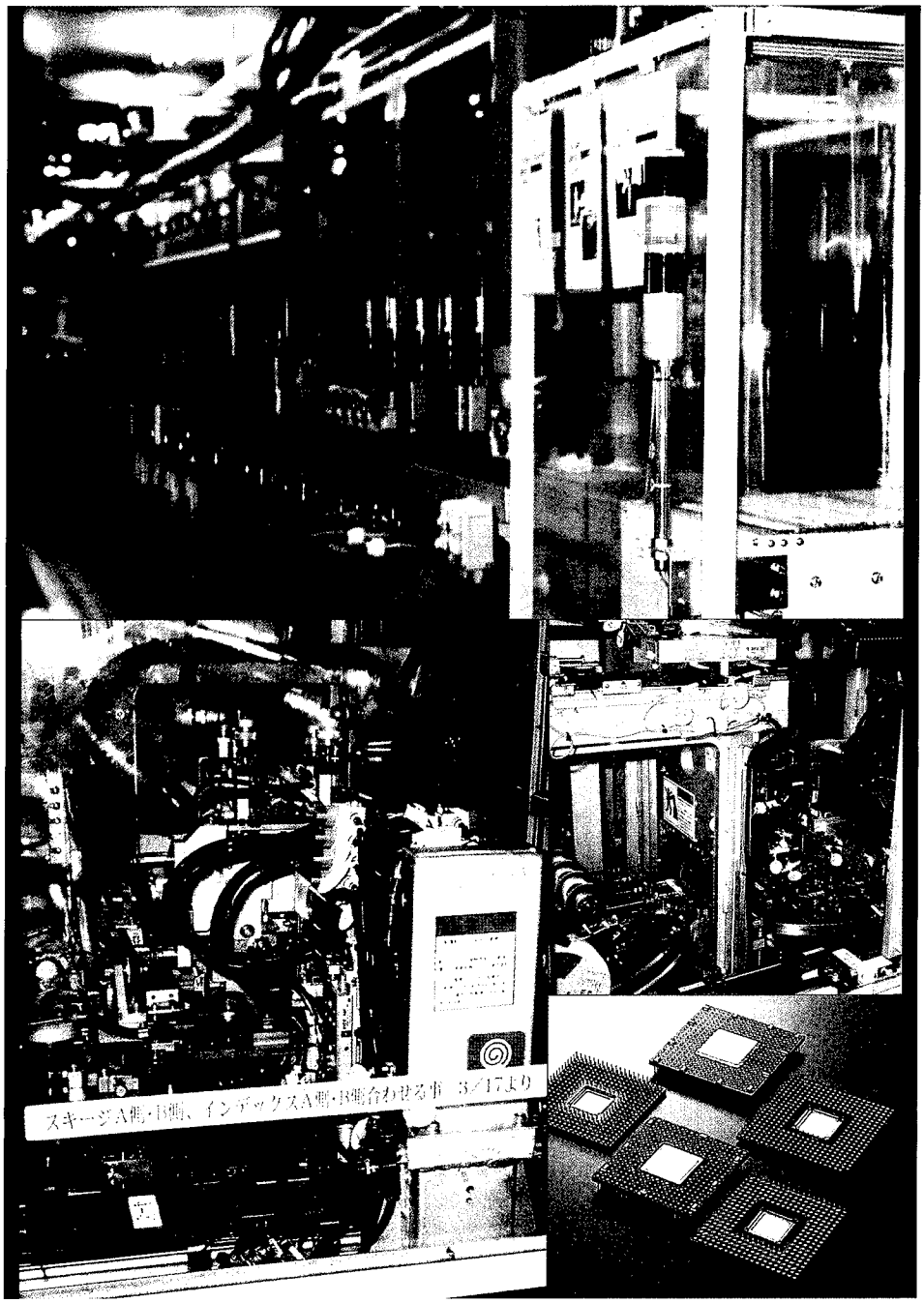
Selective Recognition of PCB by Imprint Method

SPECIAL FEATURE

Filtering System for the Internet

Demonstrative Experiment of Electronic Authentication System

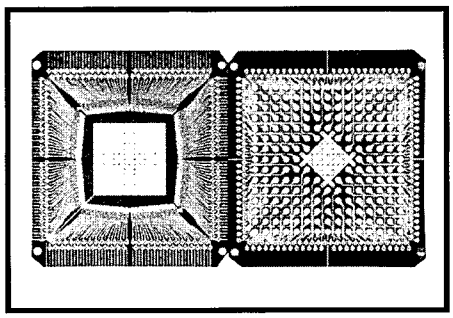
Experiment on Secure Electronic Storage System for Certified Original



JETRO

NEW TECHNOLOGY JAPAN VOL.26 NO. 3

The aim of our magazine is to promote the international exchange of technology through the introduction of Japanese New Technology.



Publisher:
Japan External Trade Organization, Machinery and Technology Dept.
2-2-5, Toranomon, Minato-ku, Tokyo 105-8466, Japan
Tel: +81-3-3582-4631 Cables: JAPANETRO TOKYO
Telex: J24378 Fax: +81-3-3582-7508

Editor:
Global Network Inc.
2-17-44, Akasaka, Minato-ku, Tokyo 107-0052, Japan
Tel: +81-3-5570-8820 Fax: +81-3-5570-2275

Production:
Three "I" Publications, Ltd.
2-2-5, Uchikanda, Chiyoda-ku, Tokyo 101-0047, Japan
Tel: +81-3-3256-3100 Fax: +81-3-3256-3170

Inquiries Concerning Published Articles

Please place inquiries on published articles directly with the firm concerned. If you require further technological information, please write to the firm concerned or editor.

Comments on the Magazine

Please send your comments concerning editorial matters of the magazine to the publisher or editor.

Cover Photo: Advanced Mass Production Lines for Plastic Package Substrates to Cope with Multi-Client Demands - Gama Plant of Ibiden Co., Ltd. -

CONTENTS

KEIRIN 本印刷物は，日本自転車振興会から，競輪収益の一部である機械工業振興資金の援助を受けて作成したものである。

NEW TECHNOLOGY & PRODUCTS 32

Advanced Materials

Electronics & Optics

Mahinery & Mechatronics

Information & Communications

Process & Production Engineering

Construction & Transportation

Energy & Resources

Environment

Biotechnology & Medical Science

INNOVATIVE PRODUCTION NOW

This section describes a specialized section or whole process of a representative factory which excels in specific aspects of production.

Advanced Mass Production Lines for Plastic Package Substrates to Cope with Multi-Client Demands

- Gama Plant of Ibiden Co., Ltd. -

1. Introduction

The development of more and more complicated and highly functional ICs and LSIs also requires more advanced multiple functions fot the packages to protect and to achieve integrated function of semiconductors.

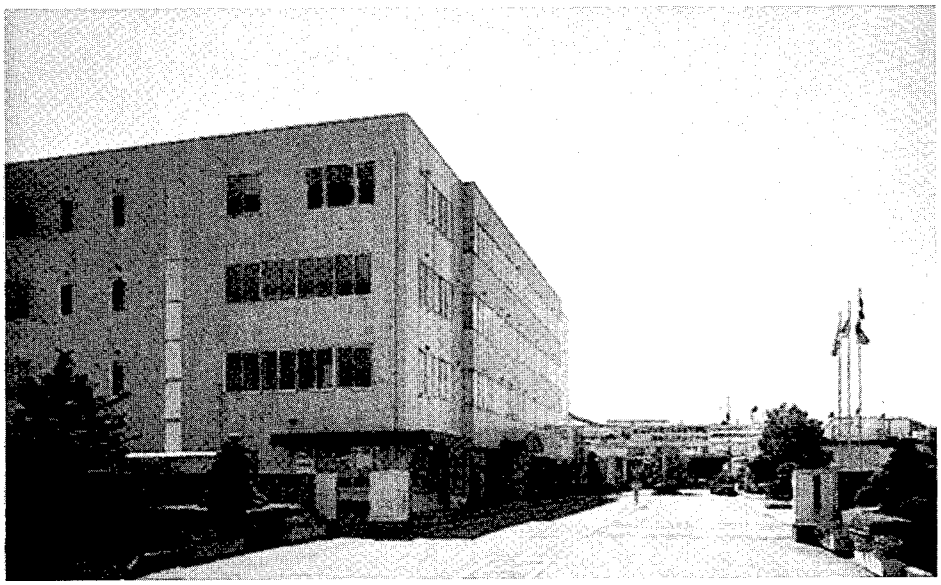
At present, there are several types of packages, such as ceramic and plastics. However, the plastic package is more highly evaluated today than the others, and application of plastic packages is expanding more and more to computers and communications devices. At present, Japan is the only supplier of plastic packages in the world except for rare cases.

However, there are many problems in the production of plastic packages, as the client specification for plastic packages changes in short time cycles, and is directed to small lot/multi-product production orders according to the change of IC performance.

Therefore, the establishment of plastic package production systems to cope with high performance multi-product/small lot requirements is very difficult.

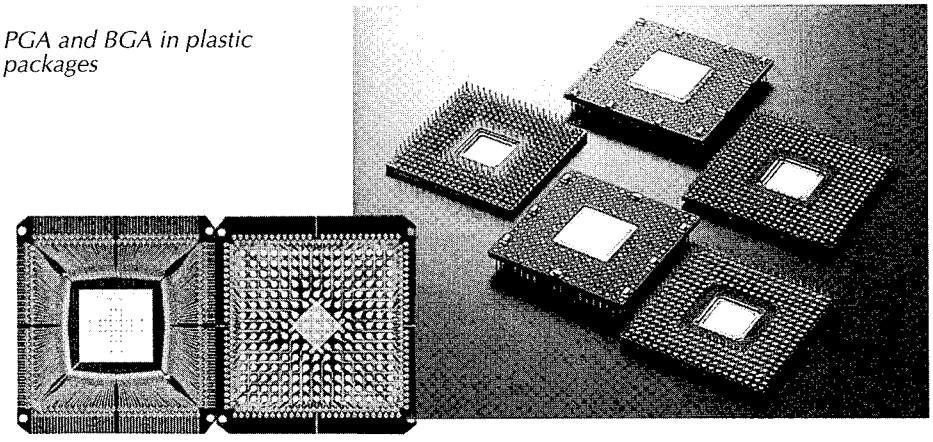
In Japan, there are a number of leading plastic package manufacturers, which are developing advanced production systems.

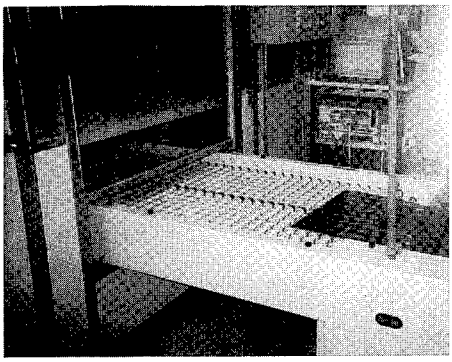
This issue introduces the Gama Plant of Ibiden Co., Ltd., a leading and pioneer manufacturer of plastic packages in Japan, which has a large share in both Japanese and world markets. Ibiden Co., Ltd. has three large products as follows: Electronics Products: various types of high-density multilayer printed circuit boards (PCB), reel to reel IC card substrates, various types of plastic packages; Ceramics Products: semiconductor applications such as single-crystal graphite materials, epitaxial growth materials, oxide and deoxidizing diffusion furnace materials, and automotive products such as electrode materials for EDM machine, sealing materials for



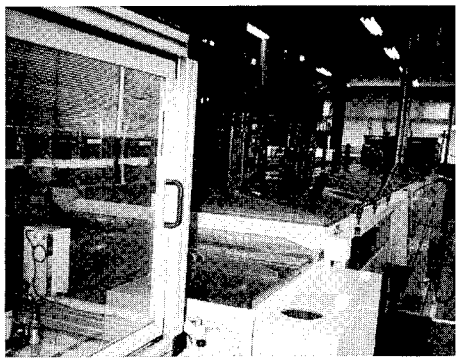
View of the Gama Plant of Ibiden Co., Ltd.

PGA and BGA in plastic packages

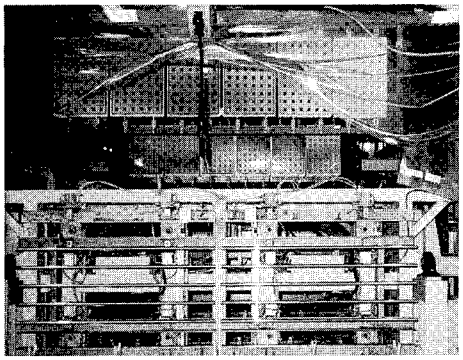




Base plastic board for hole opening (6 x 9 packages)



Photomasking operation



Open-air type Cu plating bath

catalytic converters, heat sealing materials for exhaust systems, sound insulation and absorption materials, and fine ceramics, and Housing Appliances and Decorative Products such as melanin decorative board, copper leaf decorative laminates, and other construction materials.

2. Outline of the Gama Plant

(1) Location

The Gama Plant, a key plant for electronic products, is located in Gama-cho, Ogaki City, Gifu Pref., about 2 hours from Tokyo to Nagoya by Shinkansen, and 30minutes fro Nagoya to Ogaki Station by JR Ogaki Station JR local express line, and about 10 minutes from Ogaki Station to plant site, or 2 hours 30 minutes by Shinkansen to Gifuhashima Station from Tokyo, and 20 minutes from Gifuhashima Station to plant site by taxi.

(2) Plant Outline

The Gama plant was established in 1938 and has been remodelled several times to form the present modern factory. The site area is 54,398 m^2 with two storey buildings including office and production facilities.

The major products of the plant are COB (chip on board) substrates and plastic package substrates. The production capacity is about 20,000 m^2 per month. The total number of regular workers is 410, and 640 of outsourcing. There are also many foreign workers, especially Brazilians.

The plastic package substrate production lines are divided into ball grid array (BGA) and pin grid array (PGA) lines, with the latter described here. About 2 million plastic packages are produced per month.

3. Pin Grid Array (PGA) Production Line

(1) Product and Operation System

The product of this line is the 9-layer laminated type plastic pin grid array (PGA), which is a major product for the company. The production capacity of this line is about 2 million pcs per month, and adopts 24-hour operation system in a 3-team 2-shift system (1 shift for 12 hours operation), so operates 340 days annually.

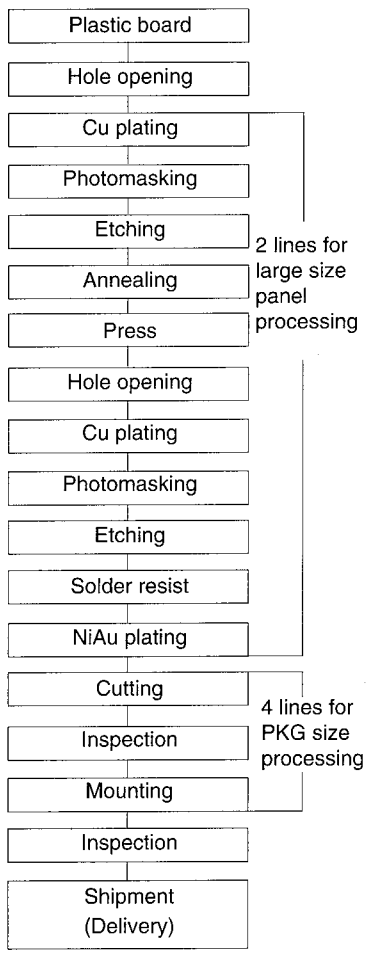
The product destination is about 20% for the domestic market and 80% for export to advanced countries centered on the United States.

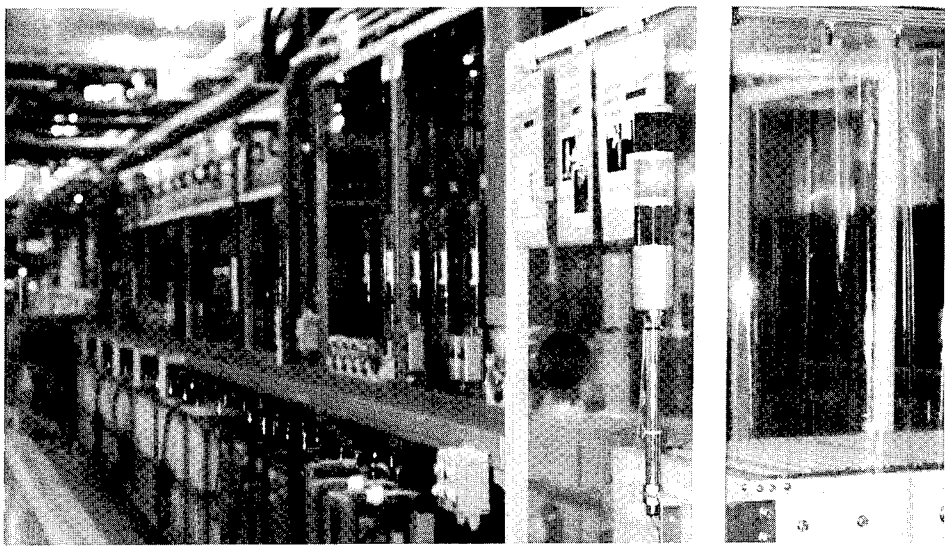
All production is based on client orders. The production process is shown in the Fig.1.

(2) Advanced and Flexible Line Concepts

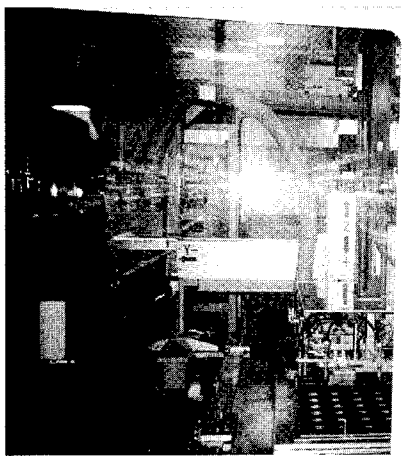
The PGA production line adopts unique systems to cope flexibly with multi-demand by clients and technical innovations

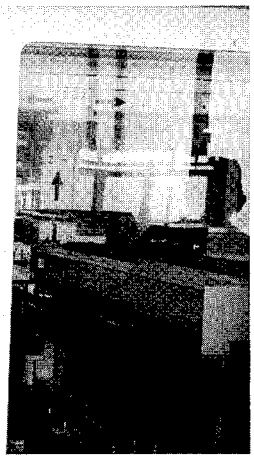
Fig.1 Production Process of PGA



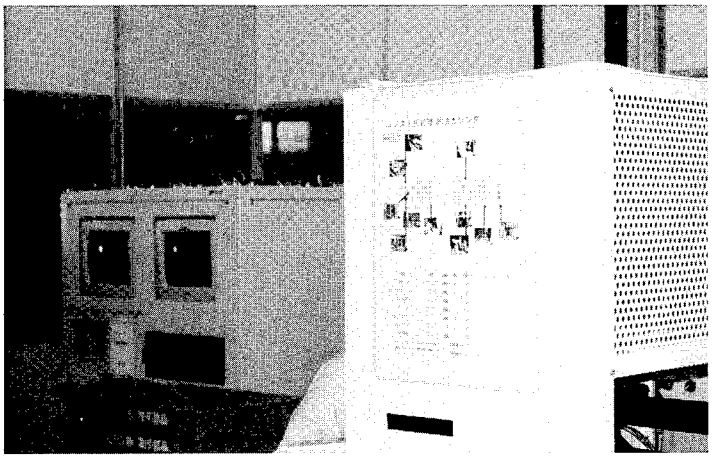


Newly developed advanced closed type Cu plating facilities





Newly developed high speed 9-layer laminating machine



Newly developed high speed inspection equipment

of semiconductors IC, and to achieve cost-effective production. Broadly classified, the line is divided into two processes; a large size processing line starting from hole opening to Ni/Au plating that is called the upstream production line, and a PKG size processing line starting from PKG size cutting, inspection, mounting, final inspection to shipment, and called the down stream line.

As shown in Fig.1, the large size processing line consists of 2 lines, and 4 lines for PKG size processing. The large size plastic board contains 54 (6 x 9) PKGs.

(3) Production Technology

Basic production technology is based on the highly evaluated multilayer and high density advanced printed circuit boards (PCB) production technologies, but unique production technologies developed by the company are adopted.

Remarkable technologies both in upstream and downstream lines are the adoption of in-line inspection systems which enable continuous operation with high efficiency.

1) Upstream Production Line

The upstream line adopts two advanced technologies.

a) Compact & Unique Closed-type Cu Plating System

Newly developed closed type Cu plating technologies and facilities are adopted. Currently, the bath planting system is used for Cu plating for plating 5 boards at a time, but the open air type electrolyte solution bath generates a small quantity of evaporation. Furthermore, the density of electrolyte solution in the bath slightly differs at the edge, so it is difficult to maintain uniform plating.

In contrast, the newly developed closed type Cu plating system is unique and provides more safety measures for workers. In this system, several plating electrodes are installed vertically, and the plastic board is also set vertically, and plated one by one when passing the front of the electrodes, achieving perfect uniform plating.

b) Automatic 9-Layer Laminating Machine

Usually, the lamination of plastic boards is carried out by manually.

However, to attain mass production and cost effective production, the development of automatic lamination technology is necessary.

As the result of trial and error, the company has developed robotic lamination technologies, and fabricated automatic board laminating machines with a capacity of 240 large boards per hour (12,960 packages).

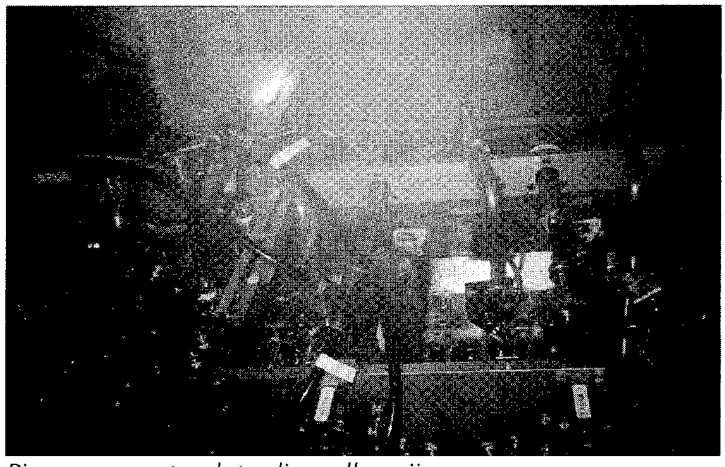
At present, this machine is in use, and is greatly contributing to reducing production costs by replacing 30 workers.

2) Downstream Production Line

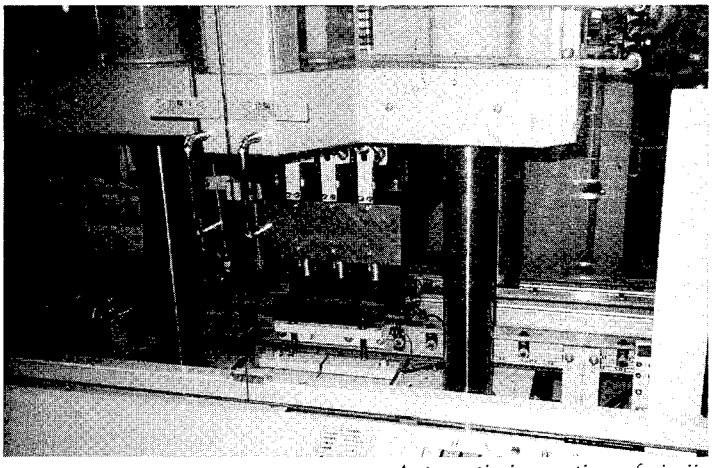
The downstream production lines consist of 4 lines started from PKG size cutting to chip mounting, and adopt the cell production system with in-line inspection equipment. Pin arrangement and standing operation is carried out by air blowing and vibration systems using various jigs developed by the company.

Pins arranged on the jig are inspected automatically, and defects such as no pin in jig hole, incomplete pin mounting, curved states, etc., are recovered at the next stage.

Heat spreader and other electronic parts such as condenser chips are mounted on the surface of PKG by mounting robots.

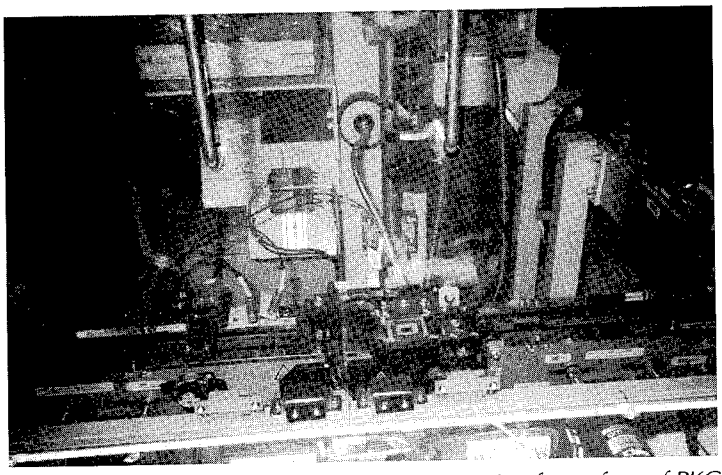


Pin arrangement and standing cells on jigs



Automatic inspection of pin jig

Visual checking of pin and perfecting pin arrangement on jig



Pin mounting operation for surface of PKG

The line length is about 17 meters and 13 mounting robots are installed per line.

a) Cell Production System

PKG size cutting to mounting and in-line inspection facilities apply cell production systems, and each cell has casters for easy line configuration and floor cleaning. Therefore, the production line can be reconfigured easily and flexibly according to the type of products.

Therefore, this production cell is used both for stand-alone and systematic production. Accordingly, the line is connected by only communications and control cables.

b) Advanced Inspection Systems

Accurate and high-speed inspection systems are essential to identify defects, evaluate product performance, etc.

The company has developed its own advanced inspection systems for the production line as in-line processes for full inspection of products and stand-alone inspection for sample inspection, and has attained perfect product quality and performance inspection.

(3) Preventive Maintenance Operation

To achieve mass production of PGA without problems, the company has adopted the preventive maintenance operation interval of a week for regular inspection using visual methods and automatic checking devices such as vibrators. Accordingly, the term problem in this company is defined as a line shut down continuing for over 10 minutes. As a result of these aggressive preventive maintenance operations, problems have been reduced to one eighth.

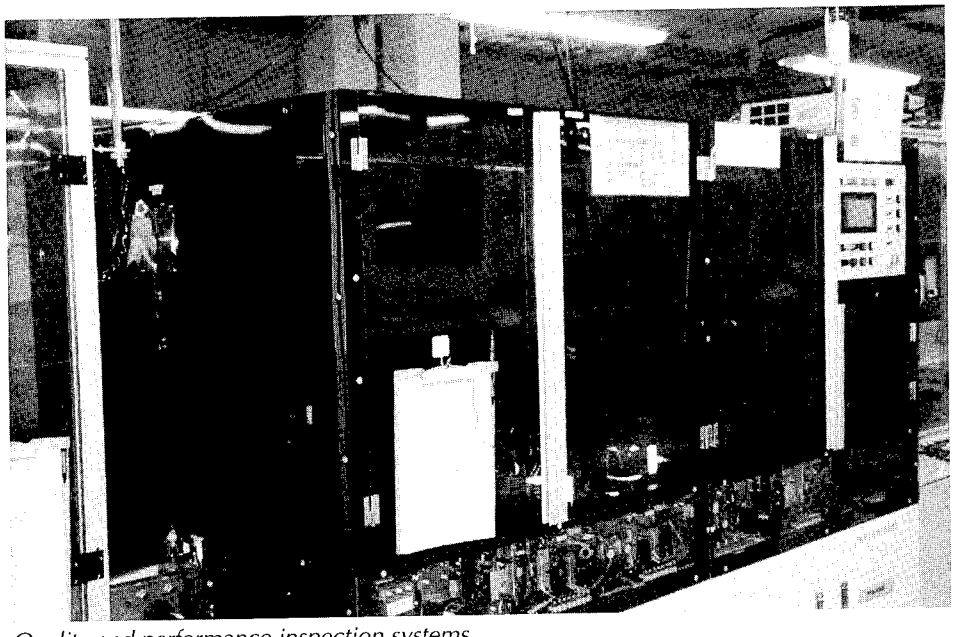
3. TPM and ISO Activities Boost Profitability

The company adopted total productive maintenance (TPM) for production in 1989 as the first phase, which resulted in good performance by reducing 20% of plant operation and management costs, and boosted productivity 2.2 times. The company received the TPM Prize in 1994.

At present, the company is aggressively promoting Phase II TPM activities including office and sales works, and will receive the TPM Special Prize in July 1998. The company is also adopting ISO 9001, and received ISO 9001 Certification in 1994, and now applying for ISO14001 in 2000.

The high production yields for PGA were achieved by the development of the cost effective production technologies as well as application of the advanced plant management methods as mentioned earlier.

The company has also developed mass production systems for ball grid arrays (BGA) based on the established PGA production technologies, and at present, trial production is being assessed for new plastic packages using newly developed production technologies for confirmation, check and evaluation of these technologies and equipment. Therefore, the Gama Plant is one of the most advanced and cost effective plants in the world for plastic package production.



Quality and performance inspection systems

Gama Plant of Ibiden Co., Ltd.
Package Substrate Division
Electronic Substrate Operation
3-200, Gama-cho, Ogaki City, Gifu Pref. 503-8559
Tel. +81-584-75-1205
Fax. +81-584-81-9470

Ibiden Co., Ltd.
Management & Coordination Group
1, Kanda-machi 1 chome, Ogaki City, Gifu Pref. 503-8604
Tel. +81-584-81+3112
Fax. +81-584-81-4676

NATIONAL R&D PROJECTS

This section describes various R&D projects being carried out in Japan on a national scale.

* ***Agency of Industrial Science and Techonology, MITI***
Medical and welfare Equipment Technology Office
1-3-1, Kasumigaseki, Chiyoda-ku, Tokyo 100-8921
Tel: +81-3-3580-6304
Fax: +81-3-3501-0576

Optical Tomographic Imaging System

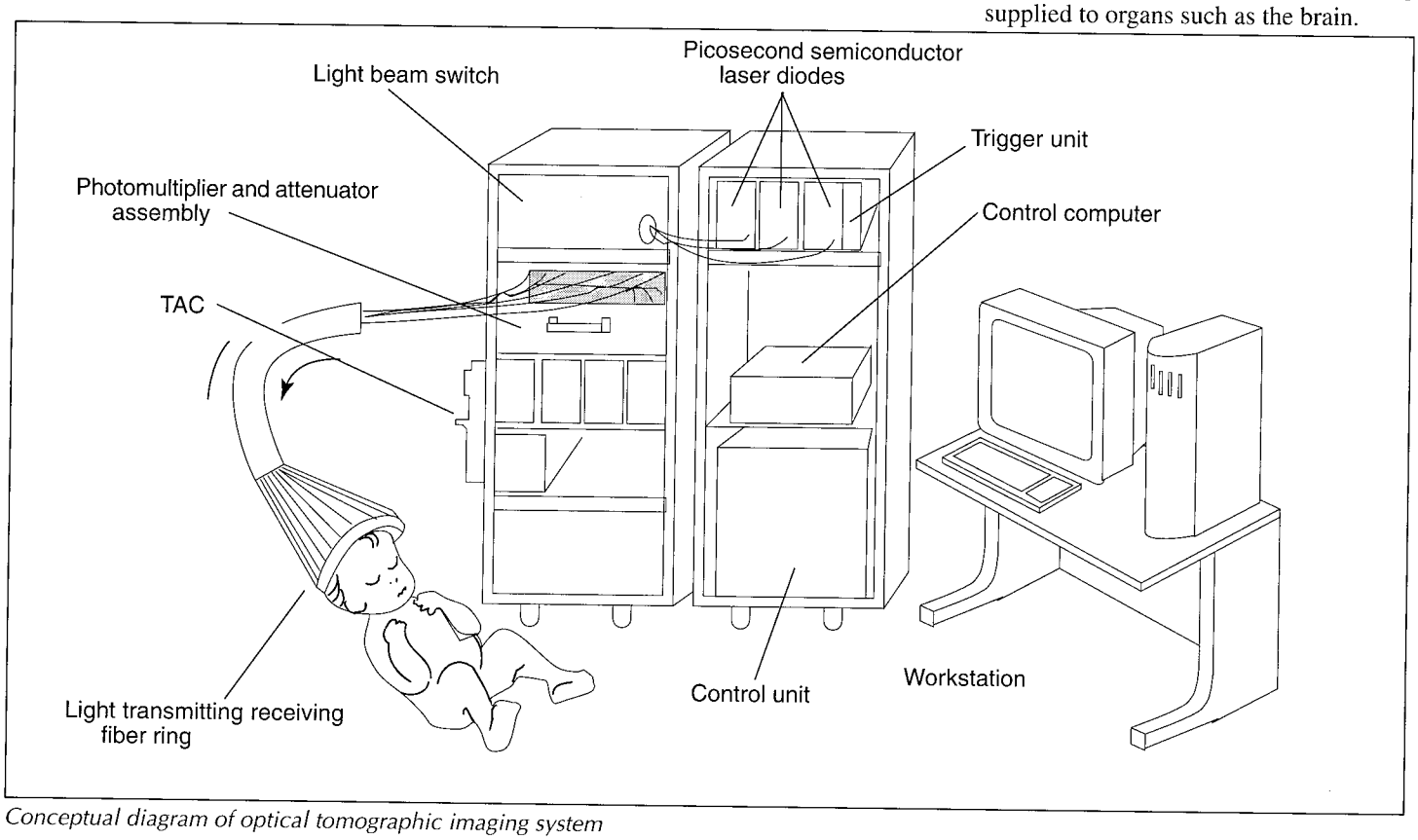
Summary

This series of articles introduces the individual projects of the Medicare and Welfare Equipment R&D Program. The first to be introduced is the Optical Tomographic Imaging System. This project developed a system to measure the oxygen metabolism inside the brain non-invasively and continuously. The research and development period extended over FY 1992-1998.

1. Project Objective: Imaging Diagnosis Using Light

In general, light does not permeate through the body, but near infrared radiation in the optical wavelength domain of 700 - 1,300 nm is known as the tissue optical window and passes through the body with less absorption. The hemoglobins in our blood, which transport oxygen to all parts of our bodies, are known to undergo near infrared spectrum changes when bonded with or separated from oxygen. Utilizing these characteristics and investigating the behavior of the infrared light directed on the body and permeating inside will enable measurement of the oxygen metabolism inside the body non-invasively and continuously.

The brain is an organ that consumes a large quantity of oxygen, and oxygen deficiency in the brain is liable to cause irreparable effects. The Optical Tomographic Imaging System is a system that enables non-invasive, continuous display of two-dimensional images which indicate whether or not adequate oxygen is being supplied to organs such as the brain.



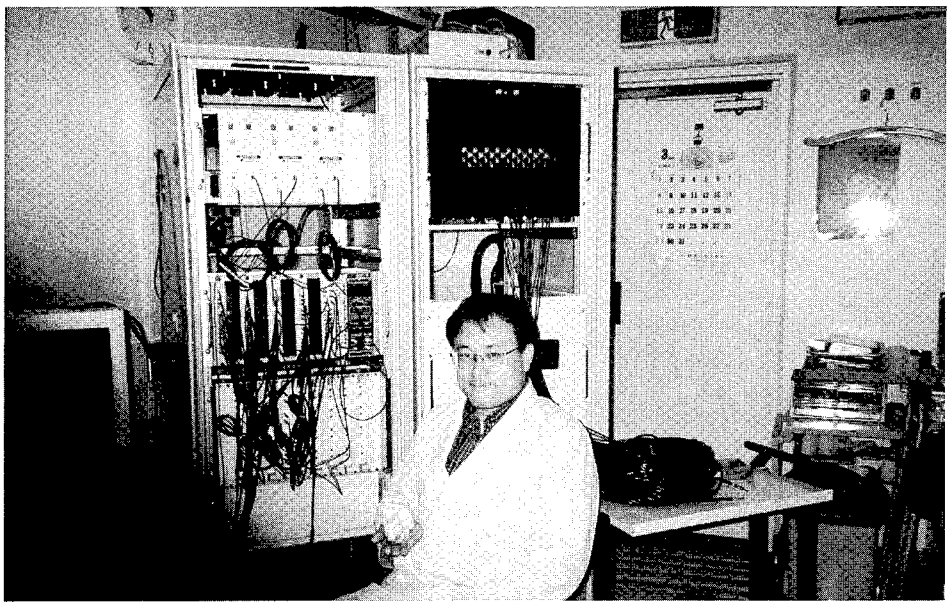
Conceptual diagram of optical tomographic imaging system

X-ray computed tomography, magnetic resonance imaging and other ultrasonic wave systems in use in medical treatment environments are excellent methods for getting "shape" information but they don't give "metabolism" information. Positron emission tomography (PET) presents excellent "metabolism" information, but it requires radioisotope injection. Therefore, the research team is presently advancing several brain function measurment system development projects, including the development of the Optical Tomographic Imaging System.

This system is ideal for use in the sector of imaging and long-term monitoring of biological information as in connection with oxygen metabolism, and is compact and operable with ease in addition to being operable in combination with other systems, so is anticipated to be a highly convenient system for conducting measurements in operating rooms and bedsides.

2. Technological Problems and Project Objectives

Near infrared radiation features very low tissue absorption, but strong light scattering occurs inside the tissues, so the radiation does not proceed in a straight line inside the body like the X-ray beam. Thus it is quite difficult and complicated to analyze information about where the light beam has passed that is necessary for obtaining internal tomographic images. Therefore, information is utilized the distance over which the light has passed. However, light is transmitted over a distance of 0.23 mm inside the body in one picosecond (10^{-12} second), so it will be necessary to develop a time-resolved technology on the picosecond level to obtain distance information on the mm level.This will require technology to irradiate extremely short light pulses of picosecond level into the body and to observe the distribution of time delay on the picosecond level. For this, a project is being advanced to develop a miniature light source that generates picosecond pulses and a system for resolution on the picosecond level. Development of a new imaging technology and an image reconstruction algorithm that involves information relating to the detected light amounts as well as the estimated total distance of light migration will also be necessary. Further, since the target is the human body and the intensity of irradiated light will be limited, a light detection technology called the photon counting method will have to be introduced that can measure very weak light beams.



Optical Tomographic Imaging System

In this R&D project, research was advanced to develop these basic technologies and systems, with the objective to establish an overall system that is usable on the clinical level. Also, animal experiments were conducted to confirm the effectiveness of these technologies and systems, and clinical evaluation advanced in parallel.

3. R&D Setup with Industrial, Academical and Governmental Participation

As described above, the development of the Optical Tomographic Imaging System demands the development of many highy advanced related technologies. Under these circumstances, as a link of the Industrial Science and Technology R&D System, research is being advanced by the Technology Research Association Medicare and Welfare Equipment Research Laboratory under consignment by the Agency of Industrial Science and Technology Mechanical Engineering Laboratory and the New Energy and Industrial Technology Development Organization (NEDO). The research project is being managed by a developmental committee consisting of experts, which is meeting three times annually to manage the project, evaluate the results and to offer advice.

Related research is advanced under the following setup. The development of a light source and detection unit is by Hamamatsu Photonics K.K., and system construction and algorithm development by Shimadzu Corporation Technology Research Laboratory. For clinical evaluation, the safety of short pulse light to the human body is studied with the cooperation of Hokkaido University and the Kanagawa Rehabilitation Hospital.

4. Human Clinical Evaluation, Progress and Future Plans

This fiscal year is the final year of the 7-year project that was started in 1992, so the development of various necessary basic technologies and equipment for the system have already been completed, and the overall system has been fabricated. With this system, simply installing multiple transmission and receiving fibers (probes) in their positions enables imaged information to be obtained in connection with metabolic functions with ease.

Up till now, subsequent to measurements and examinations with pseudo biological models, evaluation with animals has been advanced with the cooperation of the Osaka Bioscience Institute. These evaluations could assess the biological changes relating to the brain function with respect to various stimulations, and progress has been achieved to the level of confirming the clinical effectiveness of the system. The future plan is to convey the system into Hokkaido University and the Kanagawa Rehabilitation Hospital this fiscal year to conduct clinical evaluations.

** New Energy and Industrial Technology Development Organization (NEDO)*
Medical & Welfare Equipment Dept.
1-1, 3-chome, Higashi-Ikebukuro,
Toshima-ku, Tokyo 170-6028
Tel: +81-3-3987-9353
Fax: +81-3-5992-0044
E-mail: qiry@nedo. go.jp

GENERIC TECHNOLOGY REVIEW

This section describes various basic research and development activities in Japan to inform the world about generic R&D efforts here.

Studies on Simple Synthesis of Organic Compounds by Active Catalysts

* ***Agency of Industrial Science and Technology, MITI***
Research Administration Division
1-3-1, Kasumigaseki, Chiyoda-ku, Tokyo 100-0013
Tel: +81-3-3501-1777
Fax: +81-3-3501-7899

Studies on Simple Synthesis of Organic Compounds by Active Catalysts

Osaka National Research Institute, AIST, MITI
Yoshie Souma
1997-2001

Summary

Studies on strong acids, metal carbonyl catalysts, and their solidification are being performed to simplify synthetic processes for the preparation and separation of organic products. The studies focus on improvement in synthetic processes under severe conditions by using active catalysts.

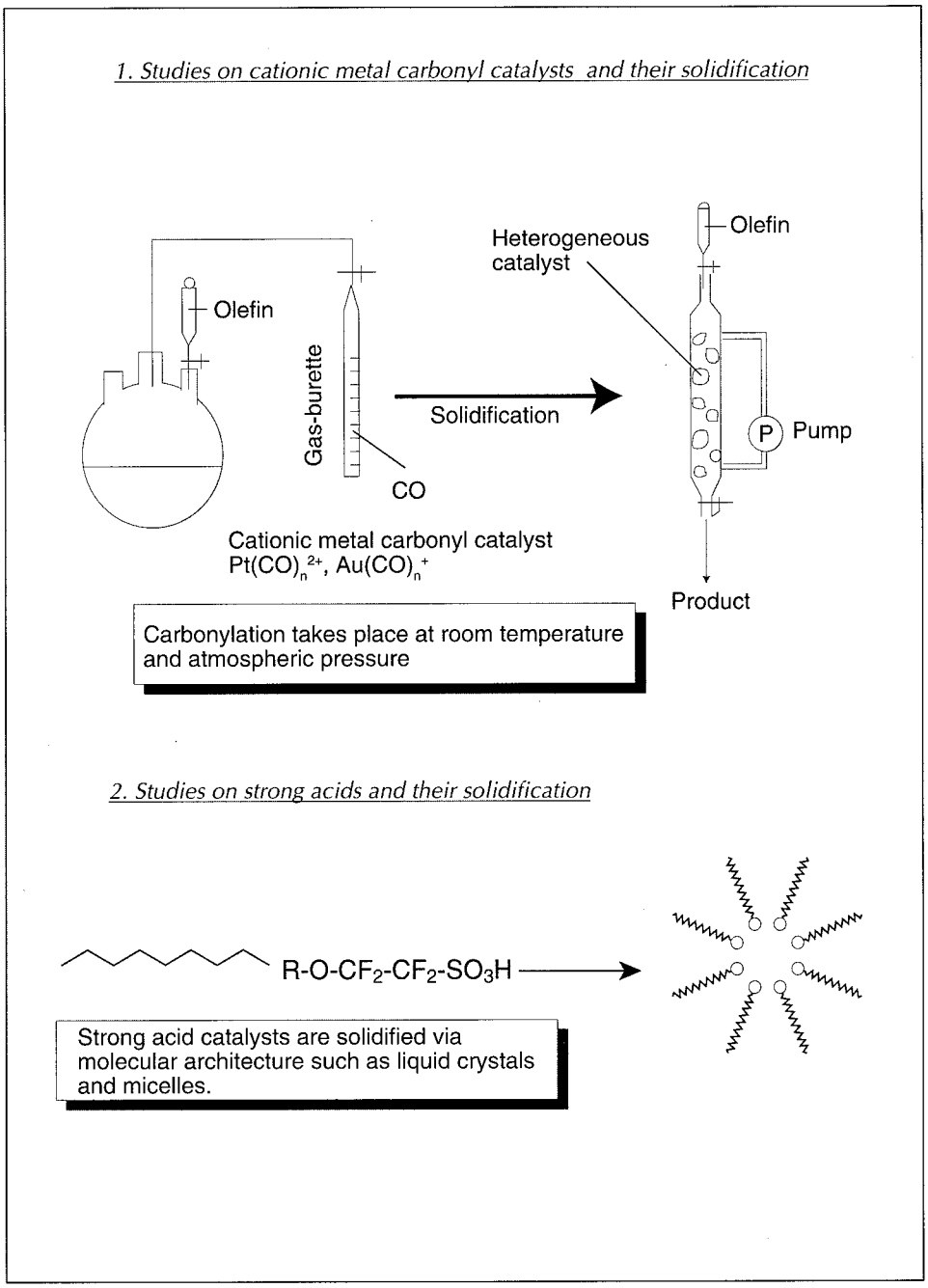
Significance of Research

Synthetic processes with a novel active catalyst will save energy and resources. The solidification of catalysts previously used under homogeneous conditions will simplify separation systems in synthetic processes and avoid toxic waste production.

Effects for Industry

For example, tertiary carboxylic acids and aromatic aldehydes, which are usually produced at high temperature and pressure, can be synthesized at room temperature under atmospheric pressure with the novel active catalysts developed by this study. The energy saving effect is approximately 22×10^4 ton of petroleum using such novel catalysts.

Furthermore, the solidification of these catalysts, especially corrosive catalysts, will have more significant advantages for both saving energy and resources and maintaining the environment by avoiding toxic waste production based on the design of environment-friendly synthetic processes.



Studies on simple synthesis of organic compounds by active catalysts

98-06-100-01

Commercialization of Optical Control Material Indispensable for Optical Data Communications

Hoya Corp. has acquired a bright outlook to commercialize an optical control material that utilizes the photon in place of the electron which is indispensable for the development of advanced optical data communications equipment. This optical control material is designed to replace the semiconductor that is currently being used as the ultracompact arithmetic processing unit (MPU) or memory, and enables data processing at a speed that is 100-1,000 times faster than existing semiconductors. The widespread use of data processing and communications equipment utilizing the photon is expected to come about in the years 2010-2020, but a big step forward has been achieved through the development of this control material that is essential and indispensable for the development of advanced photon-based data processing and communications equipment.

The newly developed material is a composite material in which titanium oxide undergoes dispersed vapor deposition of gold particles with a diameter of several dozen nanometers, and is produced by combining the laser optical irradiation and vacuum vapor deposition techniques. The company plans to distribute samples of the new material within the year.

The new material refractive index is changed with the light intensity, so by controlling the light, it performs the same actions as a semiconductor, and can be used with a light intensity of 1 kW/cm^2, about the same as that of a semiconductor laser. Up till now, a light source with a high output of 100 kW/cm^2 had been necessary, so material use in home equipment had been difficult, but this is now possible, and the refractive index change is about 100 times greater.

Semiconductors consisting primarily of silicon are limited to a processing speed of 1-10 Gbit/s, but using the new optically-controlled material provides a speed of 1 Tbit/s that is over 100-1,000 times faster. Data processing and communications equipment utilizing light feature a considerably improved data processing speed and communications volume to enable the transmission and reception of large quantities of animated images and high-speed processing, raising the probability of the optically-controlled material being used in the future in place of conventional types of electronic personal computer.

At present, the optical fiber has been commercialized as a means for optical transmission, but there is a delay in the development of optically-oriented components and equipment which actually serve to transmit and receive data, so that data processing is presently suppressed to the level of electronic equipment. When optical equipment comes into wide use and light concentrators are provided in general households, power consumption will be reduced and is anticipated to permit substantial energy conservation and reduction of exhaust gas emission.

In Japan, the New Energy and Industrial Technology Development Organization (NEDO) is implementing a project to develop basic technologies with the cooperation of industrial, governmental and academical circles commercializing advanced systems including the optical computer. Even in the United States, organizations such as the University of Arizona are rushing the development of ancillary materials but, at the present stage, research is primarily centered in connection with the optical fiber, so it appears that Japanese research is a step in front as underscored by the development of the optically controlled material.

* ***Hoya Corporation***
General Affairs Dept.
2-7-5, Nakaochiai, Shinjuku-ku, Tokyo 161-8525
Tel: +81-3-3952-1160
Fax: +81-3-3952-1314

98-06-100-02

Enzyme to Efficiently Decompose Formaldehyde

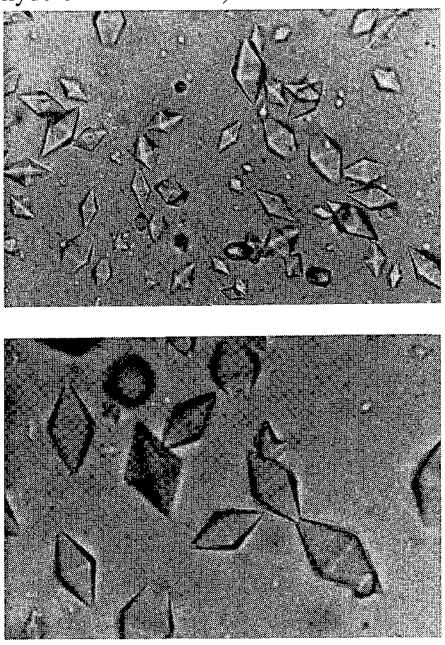
Prof. H. Yanase and his research team of the Department of Biotechnology, Faculty of Engineering, Tottori University, have discovered an enzyme that efficiently decomposes the harmful substance formaldehyde that is generated from the construction materials of newly built housing units.

Incorporating the enzyme in air purification systems enables formaldehyde to be decomposed and removed to create a healthy living environment. Formaldehyde is emitted from new construction materials and furniture, and is associated with sick house syndrome that causes physical illness in the occupants, such as eye irritations and headaches. The newly discovered enzyme should prevent the syndrome. The formaldehyde decomposing enzyme is called formaldehyde dismutase and was extracted from a strain of bacterium Pseudomonas putida F61 that proliferates in the soil. Formaldehyde coming into contact with the enzyme is decomposed into harmless formic acid and methanol.

Adhering the enzyme on a thin spongy film and passing air through the film causes formaldehyde to be decomposed naturally by the enzyme catalytic action. Therefore, using the enzyme inside air purification systems will be ideal. However, water is necessary for the decomposition reaction, so the sponge will have to be constantly retained in a wet condition.

Several enzymes have been discovered previously which decompose formaldehyde, but these enzymes cannot function independently, so the addition of an expensive substance as an auxiliary enzyme (coemzyme : NAD) had been necessary. The newly discovered enzyme requires no auxiliary enzyme and can be commercialized with ease.

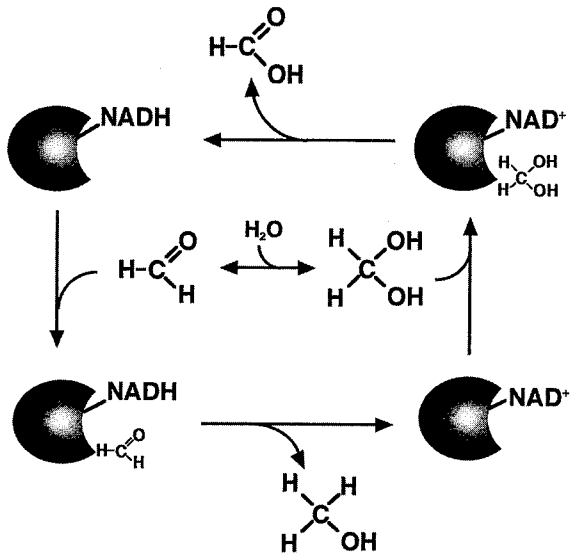
The research team separated several types of bacteria displaying excellent resistance to formaldehyde, and isolated an enzyme from bacteria that transforms formaldehyde into harmless formic acid and methanol (ratio1:1). The enzyme was named formaldehyde dismutase (formaldehyde : formaldehyde oxidoreductase). The research team



Crystalline FDM enzyme

Formaldehyde dismutase (FDM) from Pseudomonas putida F61

Localization	Cytoplasm
Structure gene	1,200 bp
	398 a.a.
Molecular weight	180,000
Subunit	4 (homo)
p/	4.8
NAD (H) bound	1 mol/subunit
(NAD/NADH)	(7 : 3)
Zn	2 atoms/subunit



also succeeded in gene cloning, and clarified that the enzyme has a structure resembling that of the alcohol dehydrogenation enzyme calconel denydrogenase.

A unique characteristic of this enzyme is that it requires no auxiliary enzyme, so it can convert formaldehyde into nontoxic substances independently. In the mechanism of this reaction, NAD(H) is strongly bounded with the enzyme proteins, so the auxiliary enzyme is not separated from the enzyme and performs formaldehyde oxidation and reduction simultaneously. Therefore, by fixing the formaldehyde dismutase onto filters, it will be possible to decompose formaldehyde specifically.

Formaldehyde is regarded as difficult to remove with ordinary air purification systems using activated carbon or ion adsorbents, but the newly discovered enzyme will permit the designing of deodorizing biocatalytic films which render formaldehyde nontoxic.

*** *Tottori University***
Department of Biotechnology, Faculty of Engineering
4-101, Koyama-cho, Minami, Tottori City, Tottori Pref. 680-0945
Tel: +81-857-31-5275
Fax: +81-857-31-0881
E-mail: yanase@bio.tottori-u.ac.jp

98-06-100-03

Selective Recognition of PCB by Imprint Method

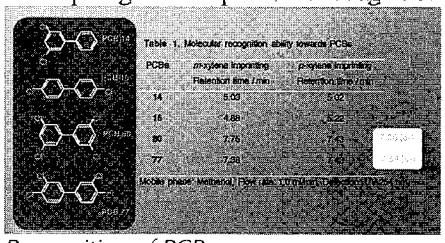
Assoc. Prof. K. Hosoya and his research team of the Department of Polymer Science, Kyoto Institute of Technology, have confirmed that selective molecular recognition of coplanar polychlorinated biphenyl (PCB) is possible by the solvent imprinting method. Molecular imprinting is the method for selecting a specific type of compound as the template and imprinting the template into a synthetic polymer to prepare a medium for recognizing the polymer specific shape and other characteristics.

However, with the conventional molecular imprint method, there is a need to use the target compound as the template, so when using PCB or dioxin as the target substance, there is a need to actually use a highly toxic compound as the template. Therefore, the research team used a compound of analogous structure as the template, performed imprinting, and by using the recognition ports (holes), attempted to prove that PCB and dioxin can be mimicked for capture by using a less toxic compound.

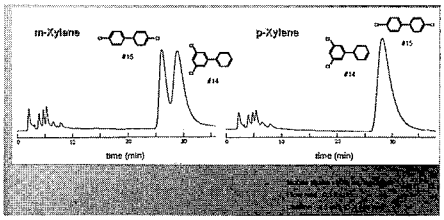
Specifically, the multistep swelling and polymerization method that provides particles of uniform diameters is adopted and three types of xylene position isomers are used as the porogenic template to prepare high-speed liquid chromatographic filling agents, and studies were advanced on the molecular recognition capabilities of these agents.

The filler agents prepared by using the three types of xylene position isomers as the porogenic template were confirmed to selectively retain the respective xylene position isomers as porogenic templates, which corroborated the imprinting effect of the porogens. These filler agents were also confirmed to display similar molecular recognition with respect to dichlorobenzenes which possess two chlorine atoms in the same positions as the xylene position isomers used as the porogenic template, indicating that a relatively tolerant molecular recognition capability is displayed with respect to compounds with analogous structures. This phenomenon was applied to the recognition of PCB.

The filler agents prepared by using m-xylene as the porogenic template provides a substantial retention effect with respect to 3, 3', 5, 5'-PCB, and when p-xylene was used as the porogenic template, the recognition



Recognition of PCB



Separation of PCB#14 & PCB#15

of 4, 4'-PCB became greater. Also, when o-xylene was used as the porogenic template, the recognition is manifested even in PCB with two chlorine atoms in the ortho position.

The advancement of applied research intensively is anticipated for this technique as the method for capturing PCB that is highly toxic which cannot be isolated in large volumes of the same isomer.

*** *Kyoto Institute of Technology***
Department of Polymer Sciences
Goshokaido, Matsugasaki, Sakyo-ku,
Kyoto City, Kyoto 606-8585
Tel: +81-75-724-7828
Fax: +81-75-724-7710
E-mail: kenpc@ipc.kit.ac.jp

Special Features

Filtering System for the Internet

Noboru Shimizu
Chief of Electronic Network Department,
Development Headquarters,
New Media Development Association

1. Introduction

The Internet is an open network system that permits anyone to place information on the network freely and with ease, and enables anyone to retrieve and utilize such information. The Internet has come into universal use due to its openness and flexibility, and encompasses the broadest range of information from governmental documents to pornography. Millions of people throughout the world are utilizing the system, and the network is continuing to expand at a fast pace even today.

In concert with the expanded utilization of the Internet in various sectors of society, attention is being focussed on the contents of the information carried on the Internet. For example, when utilizing the Internet in the sector of education, it is possible to utilize live English programs produced in a foreign country, or live information can be acquired from all parts of the world, making the system highly effective. On the other hand, there is the negative aspect of pornography being observed with ease even by persons under the age of eighteen. The present state is that such negative aspects are hampering the wide introduction of the Internet into the sector of education.

Meanwhile, in the corporate sector, the Internet has become an indispensable means for information collection and for promoting communications and marketing operations, but the system is also being used for getting access to gambling information non-related to conventional corporate activities, which is deteriorating the working efficiencies of workers and even generating the problem of nonrelevant communications traffic hampering the effective utilization of these network facilities. In concert with the expanding utilization of the Internet, harmful information carried on the network system has attracted attention as a difficult social issue.

Several countries are considering the feasibility of regulating the information carried by the Internet, but resolving this issue appears quite difficult due to the necessity of honoring the freedom of expression and the free exchange of opinions by citizens in general, the need for securing public benefits and safety, and the international nature of the Internet.

In this connection, several US venture businesses have striven to resolve this issue by supplying software permitting the selective access of Internet information, and a number of information filtering software programs have been marketed during the last several years such as the SurfWatch software. Also, in concert with the development of filtering software, research is in progress on the classification of information on the Internet, and several types of rating criteria have been developed in the United States, including the RSACi (1).

However, these filtering systems available on the market are all based on the individualistic rating data and the individualistic client software the suppliers, and therefore lack compatibility. Normally, the specific filtering need will differ with each user. In the sector of education, for example, pornographic information may become improper, and in the corporate sector, pornographic and gambling information will become problematical. In these cases, if the user employs a filtering software or filtering systems available on the market for utilizing to process other rating information, filtering was impossible and cannot allow flexible operation. (See Fig. 1.)

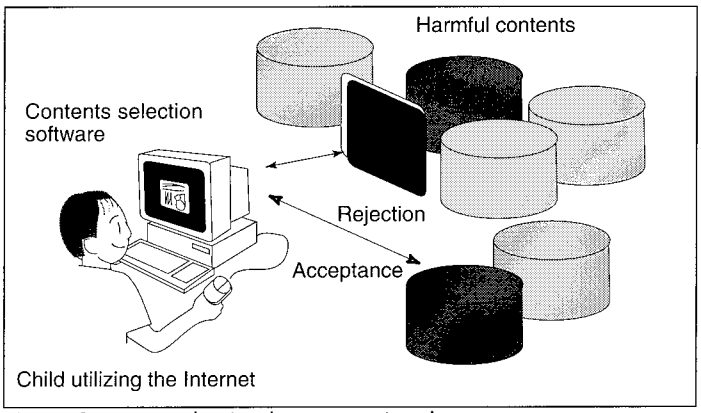


Fig. 1. Contents selection by conventional system

Filtering System for the Internet

The Worldwide Web Consortium (W3C) has established a technological specification PICS (3) for the standardization of rating data as well as for the standardization of the rating data exchange protocol on the Internet, which enables the rating data prepared in compliant with various rating criteria to be handled with various filtering software, or which enables users to select rating data matched to their specific needs. (See Fig. 2.)

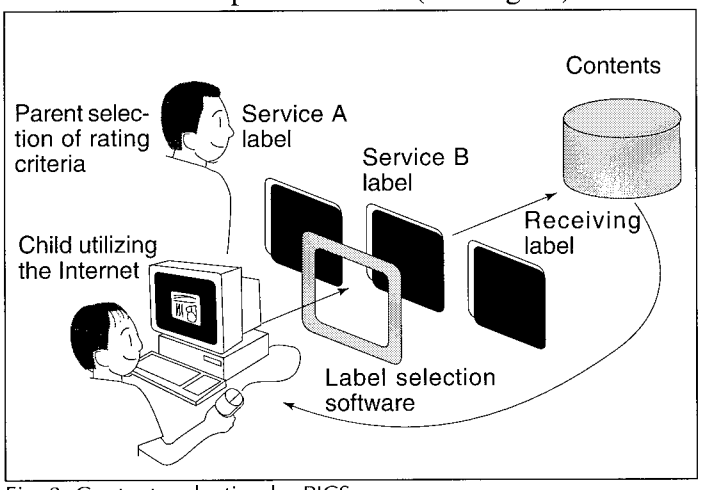


Fig. 2. Contents selection by PICS.

Filtering software and rating criteria were previously developed primarily in the United States, but only a few of these systems comply to the W3C PICS system. As for the situation in Japan, there is no rating criteria matched to the domestic need, and information transmitted from Japan is not rated so much, and even if rating was actually performed, the rating is not being accomplished properly, so it is necessary to establish a rating service or filtering system matched to the present state. Under these circumstances, the Information-technology Promotion Agency, Japan (IPA) has implemented the Filtering System Development Project for use with the Internet as a link of its creative software fostering activities.

2. Purpose of the Project

The purpose of this project is to establish a user self-management system that enables selection or management of access information by information rating with a personal rating system without having to regulate or manage the disseminated information. The procedure is to develop a standard label bureau function presently under standardization by W3C, a filtering function, and to establish a rating criteria for use in the fabrication of a data base compliant to this rating criteria for use by the information disseminator and information receiver, and demonstration tests will be conducted to verify the effectiveness of the filtering system.

3. Contents of the Project

This project consists of the three following phases: Establishing the standards, developing related technologies and verifying the system effectiveness.

(1) Establishment of Criteria

The establishment of criteria includes the establishment of rating criteria which become essential when rating the information carried on the Internet, and the establishment of PICS mounting regulations for use when mounting PICS.

(a) Establishment of Rating Criteria

When attempting to filter the information displayed on the Internet, it will be necessary to classify the information on the Internet beforehand, which is known as the process of rating. Existing rating criteria are the RSACi and SafeSurf rating criteria developed in the United States.

With this particular project, the plan had been to conduct tests by using a filtering system developed through this project with the cooperation of grammar, junior high school and senior high school students as well as private enterprises, but existing rating criteria were developed in the United States and are not necessarily compatible with the state in Japan and failed to comply with the needs of test participants. Therefore, in this project, it was decided that new rating criteria would be established to perform rating in a manner matched to the information processing patterns in Japan (primarily for working with Japanese-language home pages).

Researchers studied to what types of specific rating criteria are the most desirable when using filtering systems in the sector of education and in the sector of domestic private enterprises. Based on the recognition that the rating criteria will have to be compatible internationally, the establishment of the new rating criteria was studied on the premise that they would be compatible with international criteria as much as possible. As a result, the following two new types of rating criteria were

Level	Violence Rating	Nudity Rating	Sex Rating	Language Rating
4	Descriptor Rape or wanton, gratuitous violence	Descriptor Frontal nudity (qualifying as provocative display)	Descriptor Explicit sexual acts or sex crimes	Descriptor Crude, vulgar language or extreme hate speech
3	Aggressive violence or death to humans	Frontal nudity	Non-explicit sexual acts	Strong language or hate speech
2	Destruction of realistic objects	Partial nudity	Clothed sexual touching	Moderate expletives or profanity
1	Injury to human being	Revealing attire	Passionate kissing	Mild expletives
0	None of the above or sports related	None of the above	None of the above or innocent kissing; romance	None of the above

Fig.3. Rating Criteria for the Education Center

established based on the RSACi that is being recognized increasingly as the de facto international criteria and by adding new rating items to the RSACi: four basic rating items (nude, sex, violence and language).

* Rating criteria for education (rating service name: SafetyOnline)
* Rating criteria for private enterprises (rating service name: SafetyOnline-B).

With the rating criteria for education, the item others was added to the rating categories and the rating level was employed five stages of 0, 1, 2, 3 and 4 in the same manner as the RSACi (see Fig. 3). As for the rating criteria for private enterprises, the gamble was added newly to the rating category, and the rating level was reduced to the two levels of 0 and 1 on the judgement that it would be unnecessary to keep or broaden the RSACi classification level further.

(b) Establishment of PICS Mounting Rules

W3C technological specifications PICS Version 1.1 prescribes the general specifications for protocols when changing the label forms or when exchanging labels via the Internet, but they are not designed for strict implementation and much is left to the discretion of the user.

Therefore, in this project, a PICS Mounting Layer was established to prescribe the parts of the PICS specifications imprinted by the system which can be worked with as well as the range of the values which can be assumed by related parameters. The PICS Mounting Layer consists of the four following mounting rules:

* The Descriptive Mounting Rules which define the syntax and semantics of the labels and label lists.
* The Rating Information Home Page Descriptive Mounting Rules which prescribe the methods for implanting labels into HTML.
* The PICS Protocol Mounting Rules which prescribe the protocols for inquiring into HTML.bureau functions and the response protocols for coping with these inquiries.
* The RAT File Descriptive Mounting Rules which prescribe the RAT files describing the rating criteria.

(2) Development of Related Technologies

a) Objectives of Technology Development

The main objectives of this technology development project are to develop a common protocol relating to filtering systems, to establish a system with interoperablity, and to resolve the various matters obstructing the smooth processing of information on the Internet.

Filtering System for the Internet

Accordingly, the database storing the label information as a result of ratings (hereinafter called the label bureau) is usable using the third-party developed client, and the third-party client label bureau has also usable using the filtering functions developed this project. To achieve the development of new software easily with using rating technology, the label information method on the label bureau, the demand methods from client to label bureau, and the response method from label bureau to client must comply with the technological specifications prescribed in PICS Version 1.1 (2) developed by W3C as follows :

* Rating Services and Rating Systems (and Their Machine Readable Descriptions) Version 1.1 (document number: REC-PICS services 961031 (4).
* PICS Label Distribution, Label Syntax and Communication Protocols Version 1.1 (document number: REC-PICS labels 961031 (5).

The W3C technology specifications PICS Version 1.1 referred to in this text signifies these technological specifications. Also, compliant with PICS means compliant with these technological specifications.

b) Technologies to be Established through Technological Development

The targets of this Technology Development Project are to establish the following technologies by developing software which conform to W3C Technological Specifications PICS Version 1.1:

* Technology for the effective rating of information carried on the Internet.
* Technology to establish a database and to manage the label information produced through rating.
* Technology to include label information into home pages.
* Technology for placing label inquiries on the label bureau when getting access to the Internet through a browser.
* Technology for filtering based on label information acquired from label bureaus.
* Technology for filtering based on label information acquired through home pages.
* Mounting technology for the realization of filtering without being influenced by the type of browser.
* Technology enabling filtering without requiring the development of a new software even when the rating criteria are altered.

The technologies established through this project have a wide range of applications, such as the new Internet search services, intellectual property right protection systems, anti-virus computer systems and electronic commerce system.

c) Outline of Technology Development

The objective of this project, in view of the expanded utilization of the Internet, is to establish a rating service to support the self-management of information reception via the WWW and other sectors of the Internet. So, the development of filtering system, which is required for realizing to provide the rating services utilizing educational and enterprise rating criteria, was conducted to comply with the PICS Criteria for software and web site developers who usually use the W3C PICS Version 1.1 and the PICS criteria for development.

Actually, the filtering systems developed in this project have the following functions as a label bureau function (to respond the registration and inquiries of label information via a browser), a filtering function (for judging the propriety of displaying label information on the home pages provided from the label bureau), and an authoring function (enables the self-rating by the Web site developer) (see Fig. 4).

The label bureau function operates on a UNIX machine, and consists of following functions: The function of storing and managing of the label information as the results of ratings, the function to conduct effective rating operation and of the label bureau management by label bureau manager via a browser, the function of receiving the inquires, inquiry treatment & response required from the PICS-compliant software including the filtering functions developed by this project, and the function of enabling a general user of the Internet to request the label bureau manager to conduct rating of a designated home page.

The Internet involves an enormous volume of information, so conducting rating work on all these information would be quite difficult and inefficient, and this the label bureau function is interlinked with the country's leading retrieval sites to enable the home pages which are likely to become the targets of ratings to be weeded out for increased efficiency. The label information which is the result of rating is managed in the form of a data-

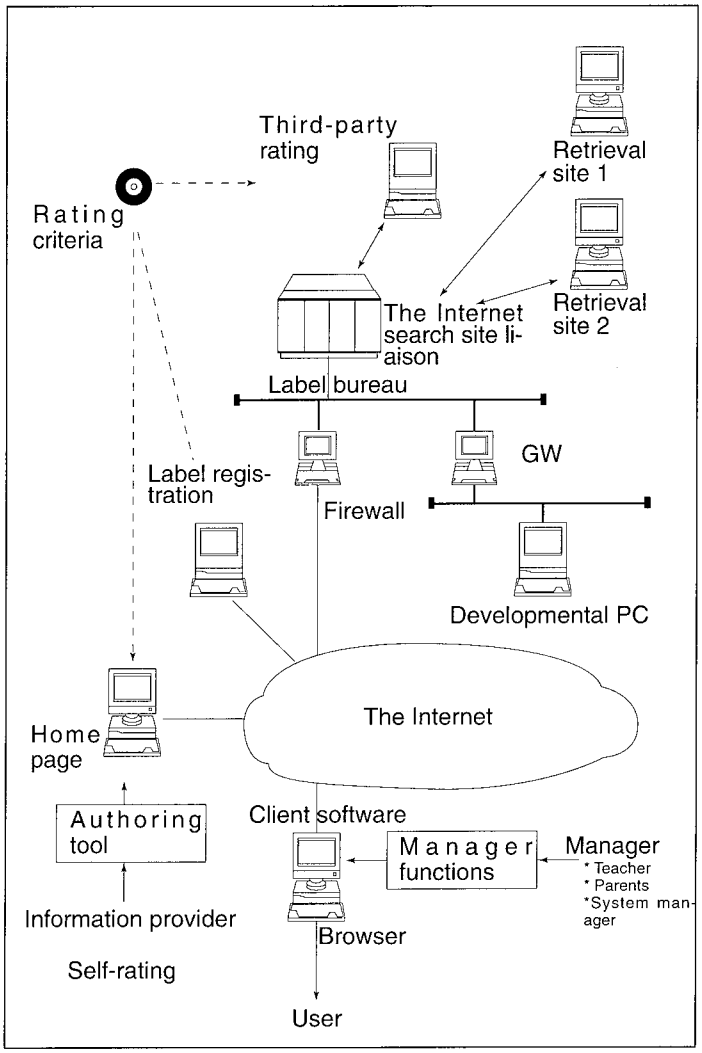


Fig. 4. Schematic diagram of filtering system

base, and the database management function for label bureau manager has been made available in an easily operable user interface by use on the Web. Regarding this label bureau function, the label information as a result of rating is in compliant with PICS to enable interoperability of label information.

Also, the label bureau function includes a function as an HTTP server and can accept PICS-compliant label inquiry commands from software on the Internet, and whenever some inquiry command is received, perform appropriate processing compliant with the inquiry commands concerned and to return PICS-compliant response to software which dispatched the inquiry commands. In this manner, by making the communications protocols relating to label inquiries PICS-compatible, the label bureau functions and the filtering functions have been made mutually interoperative.

The filtering function is available in two types of software, one for operation on Windows 95 and the other on Macintosh.

The filtering function consists of several functions, such as a server function that instructs, which PICS-compliant label bureau function will be used, also a function that judges the propriety of displaying a home page concerned based on the label information obtained from the results of label inquiry demands placed by the PICS-compliant server including the newly developed label bureau function whenever a home page display demand is raised by a browser, and a function that enables the access manager including a teacher or parents to manage the browser user with ease.

The filtering function, when representing the Internet network architecture with a 7-layer Open Systems Interconnection (OSI) model, will represent No. 4-layer (transport layer) of the 7-layer model. When an the Internet user gets access to the Internet via a browser, the URL that indicates the access point will pass through No. 4-layer (transport layer). The filtering functions traps this URL and compares the URL label information and the threshold value preset by the access manager to determine the propriety of access permission.

Therefore, filtration will be possible without being influenced by the specific type of browser that lies in the position of No.7- layer (applications layer). The label information used in filtering may be based on information supplied from the label bureau or information supplied from the home page (in case of self-rating). When extracting label information from a label bureau, the filtering function uses a PICS-complained communications protocol with respect to the label bureau preset beforehand by the access manager, performs label inquiry, then acquires the label information corresponding to matched URL.

Therefore, the newly developed filtering function can be used with virtually any kind of label bureau as long as it is a PICS-complained label bureau. Also, when extracting label information from a home page, the prerequisite will be for the label information to exist in PICS-compliant form in the header of the home page.

The authoring function is available in two software versions, one for Windows 95 and the other for Macintosh.

Filtering System for the Internet

The authoring function is designed to easen the self-rating of home pages by Web site designers, and consists of a function to insert PICS-compliant format label information into designated home pages and a function to insert GIF format image data to indicate that rating has been achieved for the home page concerned.

The label information, the result of rating, may possibly be prepared in compliance with different rating criteria. If the user interfaces and the processing logics of the label bureau function, filtering function and authoring function were based on different rating criteria, then it will be necessary to use software of various functions to cope with each of these rating criteria. To eliminate this inconvenience, PICS specifies a data file (RAT file) that defines the rating criteria. The newly developed RAT file enables the user interface and processing logic to be changed actively in compliant with the definition of this RAT file to eliminate subordination to these rating criteria.

(3)Effectiveness Verification Tests

To verify the effectiveness of the rating criteria established through the criteria development phase as well as the filtering system developed through the technology development phase, the Internet users were requested to utilize the filtering system developed through this project, and effectiveness verification tests were conducted.

These tests were carried out in two parts, one to verify the effectiveness of the rating service for the sector of education, and the other to verify the effectiveness of the rating service for the sector of private enterprises. A description of these tests is offered here for reference.

a) Test to Verify the Effectiveness of the Rating Service for Education

This test was primarily conducted in concert with New 100 School Project of the Computer Education Center (CEC), also with the participation of several other schools which desired to participate in this test, and was conducted during the period from October 1997 to January 1998. Prior to the test, about 10,000 cases of home pages were rated for compliance with the rating criteria for education that was developed through the criteria development phase, and the results stored into the label bureau for use as a SafetyOnline rating service.

The rating work for education was performed on and off during the test, so ultimately, the total number of rated home pages was about 13,000 cases. In this test, teachers were employed as the access managers, and the students as the filtering function users.

The filtering function developed through the technology development phase was installed in the Internet access PCs utilized by the students of the test participating schools, and while actuating the filtering function used in the rating service, the students were requested to utilize their PCs as in their curriculum and extra-curriculum activities, while test data were collected from the utilization logs and questionnaires, and the following items were analyzed and evaluated.

* Effectiveness of the filtering function in educational sites.
* Propriety of the label data base prepared in compliance with the rating criteria for education.
* Operability of the filtering function when applied to educational sites.
* Operability of the label bureau function.

b) Test to Verify the Effectiveness of the Rating Service for Private Enterprises

In this test, three private enterprises which utilize the Internet in concentration were requested to participate, and PCs were used as in daily work operations. Prior to the test, the rating criteria for private enterprises developed through the criteria development phase were used, about the same number of home pages was given rating as in the case of the education test, and the results were stored in the label bureau for use as a SafetyOnline-B rating service.

In this test, the filtering function developed through the technology development phase was installed inside the PCs used in their actual work by the test participants, and while operating the filtering functions used in the rating service as of SafetyOnline-B, the participants were requested to engage in their daily duties by using these PCs, and test data were collected through the utilization logs and questionnaires.

The test data were analyzed and evaluated in connection with the following items:

* The effectiveness of the filtering function at private enterprise worksites.
* The propriety of the label data base prepared in compliant with the rating criteria for private enterprises.

* The operability of the filtering function when applied to private enterprise worksites.

c) Results of these Tests

The essential results of these tests at educational sites and private enterprise worksites may be summarized as follows:

* Effectiveness of the Filtering Function

  In both these tests, access blocks were generated by the filtering functions. However, the frequency of generation of these blocks was quite insignificant compared with the number of accessed URLs. An analysis of the generation state of these access blocks showed that they were generated not by the testing of the filtering function but rather through the actions of users to get access to harmful information.

  As judged from these results, the filtering function is effective, and the results of a questionnaire also underscored the effectiveness of the filtering function.

* Propriety of Label Data Base

  Whichever the label data base, whether for education or for private enterprises, the number of claims from users was quite small, and even as viewed from the questionnaire, the label data of this project was evaluated highly in that the degree of inclusion of ratings relating to the Internet information for Japanese users is very high compared with other systems.

* Operability of Filtering Function

  Filtering functions include the stand-alone type which is used by installing independently into PCs, and the server types which are installed into proxy servers and used for performing filtering of multiple PCs. The filtering function of this project belongs to the stand-alone type, so there were many claims that installing one by one into several dozen PCs in the classroom was cumbersome. However, the evaluation was that the operability of the filtering function itself was good.

* Operability of Label Bureau Function

  In the test, the label bureau function was operated only by the New Media Development Association (NMDA), and the persons who evaluated the label bureau function operability were only a few staff of NMDA. Therefore, no general objective evaluation was acquired, but the evaluation of the operators was that there was no particular problem in the function user interface as well as in the function performance.

4. General Results

The results of this project may be divided into the technological results and the test results.

(1)Technological Results

The technological results of this project may be summarized as follows:

* Highly effective rating technology was developed for information on the Internet by coordination with various the Internet search services.
* The database production and management technology was developed for label information.
* An access information trapping technology was developed at a transport layer for use when getting access to the Internet through Windows 95 or Macintosh via a browser.
* A filtering technology based on the using label information from the label bureau and label information existing in home pages was developed.
* A technology was developed that enables a specific type of label bureau responding to the user need to be selected flexibly in the event various label bureaus exist with level information prepared in compliant with various rating criteria.
* A PICS-compliant filtering software was developed that is usable on Windows 95 or Macintosh, and is open to the general public as a free software for use on the NMDA home pages.
* An authoring software was developed for the convenience of self-rating of home pages by Web site developers that is usable on Windows 95 or Macintosh, and is open to the general public as a free software for use on the NMDA home pages.
* A PICS-compliant label bureau software was developed that is operable on UNIX.
* Unique rating criteria was developed for the NMDA educational purpose, also rating criteria for use by private enterprises, which are based on the RSACi

rating criteria and on the opinions of education-related persons and corporate system managers.

* Based on a rating criteria for education, an educational rating service SafetyOnline has been started primarily for the rating of home pages for Japanese users in the sector of education.
* Based on a rating criteria for private enterprises, a rating service SafetyOnline-B has been started primarily for the rating of home pages for Japanese users in the sector of education.

(2)Test Results

The test results of this project may be summarized as follows:

* In concert with the New 100-School Project of CEC, a test was conducted to verify the effectiveness of the filtering system at the educational sites of grammar, junior high and senior high schools. The results corroborated the effectiveness of the filtering system, and promoted the application of the filtering system to schools.
* With the cooperation of several corporations which became pioneers in the Internet utilization, tests were conducted to verify the effectiveness of the filtering system at corporate worksites, and activities were advanced to promote the filtering system application by private enterprises.
* The effectiveness verification tests were advanced by a task force including the main domestic filtering software suppliers and by engaging in various related studies. The working group served to standardize the filtering system, also pointed out the vital importance of standardizing the filtering system and making related data interchangeable.

5. Issues to be Resolved in the Future

The implementation of this project weeded out the issues which have to be resolved into the future in connection with the filtering system relating to the Internet.

* The project verified the effectiveness of the filtering system, but when the filtering system developed through this project comes into wide use in the future, the traffic requiring access into label bureaus is certain to increase considerably. The label bureau computer system used in this project was designed specifically for conducting tests, and did not anticipate millions of users of the filtering system. To permit the system to offer full-scale services to millions of filtering system users, it will be required high performance distributed or fault tolerance computers as label bureau computer system.
* In this project, the rating was performed by the third-party rating method in which the rating is accomplished by a third-party not related to the Web designer, but considering the efficiency of the filtering process and the tremendous labor involved in the rating work, the self-rating method should be adopted in which the Web designer performs the home page rating work.
* In this project, a system was established to support the rating work, and the rating of home pages primarily for Japanese users was performed for about 13,000 cases. Much time and labor were expended for this rating work and, subsequent to rating, adequate follow-up of altered home pages and eliminated home pages was impossible due to the lack of manpower. Further research will be necessary not only in connection with text data but also on an automatic rating system for image data home pages, and to establish an automated system for the renovation of label information as the results of rating.
* Information carried on the Internet is provided from all over the world, and any user of the Internet can get access to these information with ease. Therefore, it will be necessary for the filtering system to be coordinated worldwide, for which it will be necessary to establish commonly usable international rating criteria as well as a system for the exchange of label information.
* Information carried on the Internet is provided from all over the world, so involve a tremendous volume of information prepared in various languages, and undergo rapid changes. Therefore, it appears that the rating of the Internet information throughout the world with a single label bureau may be impossible, which suggests that it may be necessary to study a distributed system similar to that of the domain name system (DNS) for the label bureau system.

Demonstrative Experiment of Electronic Authentication System

Nobuyuki Tamba
Senior Researcher,
New Media Development Association

1. Background

In Japan, the concentration of information-oriented investments by the industrial and commercial worlds and the widespread use of data communications-related equipment by general households have increased the number of the Internet users to about 8 million. Today, electronic commerce including the conducting of business transactions, placing applications, drafting contracts and settlement of accounts are being accelerated through open networks represented by the Internet , not only in the sectors of public enterprises but as well between enterprises and individuals and even between individuals.

Electronic commerce differ radically from the conventional method of using documents and of face-to-face transactions, and today electronic documents are exchanged increasingly via electronic network systems. Naturally, securing the reliability and safety of these transactions is essential.

Various matters will have to be resolved to make electronic commerce safe and reliable, so the Electronic Commerce Promotion Council of Japan has compiled three conditions which derive from the nature of electronic commerce, as follows:

1) Since the documents and various other related data are processed electronically, there will be no traces of alterations/erasure/forgery. Also, the original/duplicate copies of electronic data cannot be discriminated with ease, so it will be necessary to guarantee the authenticity of related data.

2) Since the transactions are advanced without parties meeting, a system will be necessary for the recognition of the partner as the real partner.

3) Since the transactions are performed on an open network and there is the possibility of electronic data interception/tapping/tampering, the secrecy of data has to be secured.

Effective means to resolve these three conditions include the electronic authentication system, the electronic certification system and the electronic signature system. To introduce these systems as a new social information infrastructure to support economic and industrial activities in the advanced information society, the Advanced Information and Communication Society Promotion Headquarters International Trade and Industry and the Ministry of Justice have begun research to identify and resolve related problems in the technology, composition, and legal and systematic conditions. The electronic authentication system., in particular, is effective for coping with condition 1) that is the greatest hazard to the data preservation system, and is anticipated as the springboard to alleviate the controls for the electronic preservation of ledgers, for which preservation is obligated by the existing personal income tax and corporate income tax acts.

Already, in the United States, private enterprises have emerged which supply electronic notary services, such as Surety Technologies, Netdox and USPS. Perceiving that the commercialization of the electronic notary service is just around the corner in Japan, it is desirable that the diverse conditions and environment for the commercialization of the electronic authentication system are substantiated as soon as possible.

2. Objectives

In view of the debates being conducted in Japan in connection with the electronic authentication system and the electronic certification system, in this demonstrative experiment, the electronic authentication system is defined as an electronic information administration system managed by some public organization or comparable organization or group, and a social system/information processing system to verify the facts (such as who, when, with what documents and papers, and to whom they were dispatched) whenever a demand is raised in connection with the methods and mode of preservation, to eliminate the fear of alteration or deletion of the contents of electronic information such as the documents and papers registered by an individual or multiple users.

In this demonstrative experiment, the main objective is to verify whether the electronic authentication system is effective or not for the prevention of "transactions, account settlements as well as conclusion of contracts in the pretence of the individuals concerned," "the alteration of business transaction facts through the alteration or omission of electronic information contents exchanged between the proper transaction parties," and the prevention of "subsequent denial of the facts of commerce conducted earlier," in the diverse business applications involving different business fields, business contents and differing service suppliers and which are carried out through the Internet and personal computer network system, by utilizing the electronic authentication system developed and operated in conformance with this definition.

Demonstrative Experiment of Electronic Authentication System

Also, in concert with this experiment, studies are to be advanced on how to establish the electronic authentication system as a new social information infrastructure that will be indispensable for the realization of electronic commerce in the advanced information society. The advantages and disadvantages of the system are also to be studied while simulating and considering the service supply system and service charging system to be adopted for providing the electronic authentication system.

3. Outline of Electronic Authentication System

The basic construction of the electronic authentication system developed, operated and controlled in this demonstrative experiment, as well as an outline of the services and functions supplied to system users are described here.

(1) Basic Construction of Electronic Authentication System

To make the electronic authentication system developed through this demonstrative experiment compatible not only with condition 1) but also with conditions 2) and 3), it is comprised of three types of software proposed by the Electronic Authentication Center, the Electronic Authentication Clients and the Certification Authority (CA), and has the following characteristics:

a) Communications by Secure Mail

To establish communications with the Electronic Authentication Center safely and reliably through the Internet and online, the PEM (Privacy Enhanced Mail) is introduced that is a sort of E-mail for encryption of messages and for distribution of cryptographic keys. The PEM in this experiment uses the common key encryption DES (key length: 128 bit) and the public key encryption RSA (key length: 512 bit) in combination.

b) Preservation with Recording Medium Preventing Alterations/Erasure.

A postscript type recording medium is introduced to guarantee reliable preservation of E-mail as well as ancillary documents and papers (referred to as electronic documents) registered at the Electronic Authentication Center from being altered/erased physically.

c) Issuance of Public Key Certificate by Certificate Authority (CA).

To prevent communications under pretense of certified users, a Certificate Authority (CA) is established to control the public keys possessed by dispatchers and to issue public key certificates. The CA issues IC cards and/or floppy disks containing the user's ID card number, secret key and the public key certificate.

d) Access Control to Electronic Documents

In addition, to enable common possession and utilization of electronic documents registered at the Electronic Authentication Center by multiple users, an electronic document access right may be established.

(2) Services and Functions Provided by Electronic Authentication System

The services and functions provided by the Electronic Authentication System may be classified broadly into those related to registration, delivery, enquiry, certification and seal affixation.

a) Registration Service

This is a service to preserve electronic documents. Registration ownership can be designated, and the documents are given a registration number. The Electronic Authentication Center also displays a registration function and a postscript registration function.

b) Delivery Service

This is a service to deliver the electronic documents registered at the Electronic Authentication Center to the designated rightful owners. Delivery is possible only to designated access right holders and registered members with proper registration attributes. The Electronic Authentication Center also possesses a document opening function in addition to its delivery function.

c) Enquiry Service

This is a service to dispatch electronic documents registered at the Electronic Authentication Center to authorized requesters. Inquiries can be made into the document registration number, and probing into the time of registration, document title and other matters is possible. Thus, the Electronic Authentication Center provides a search and enquiry service.

d) Certification Service

There is also a service to reprint the documents registered at the Electronic Authentication Center for mailing to a rightful requester as a certificate of registered

Fig. 1. Trademark

document. In this certification service, the trademark shown in Fig. 1 is imprinted to verify that the document has been certified by the Electronic Authentication Center. The postal matter carries the registered number of the document and the name and address of the dispatcher.

e) Signature Service

This is a service to get the approval of all the signers of an electronic document registered at the Electronic Authentication Center. The approval of all signers is obtained, and the result of approval is informed to all signers. Electronic documents with approvals of all signers are distributed.

4. Contents of Demonstrative Experiment

This demonstration experiment was conducted to verify the effectiveness of the Electronic Authentication System with respect to five commercial applications which were classified by target field (public/civilian), commercial contents (application, notification/settlement/transaction) and type of user (end user/service provider).

Also, this demonstrative experiment provides a lead to judging whether or not the Electronic Authentication System would permit the establishment of a public business operation in opened electronic networks, so simulation was performed in connection with the service charge and charge rate for the services provided by the Electronic Authentication System by using the document text sequence numbers, registered file numbers and preservation periods relating to the aforementioned business applications. Table 1 shows the contents of the demonstration experiment items.

Item Target	Field Business	Content	Type of User
Online test application processing work	Public	Notification/application	Service provider
Notary public document submitting work	Public	Notification/application	End user
Sales work through outdoor terminals without a store	Civilian	Transaction/settlement	Service provider
Antiquarian book selling work	Civilian	Transaction	End user
Electronic publications copyright control work	Public	Notification/application, transaction	End user
Electronic Authentication System service charge and charge rate	———		

Table 1. Contents of demonstrative experiment items

Demonstrative Experiment of Electronic Authentication System

5. Demonstrative Experiment Environment

In the demonstrative experiment, the Electronic Authentic System installed in the New Media Development Association was linked to the Internet (including online services) by a OCN 1.5 Mbps network. The clients and servers in diverse business by relying on their respective hardware network environments, were connected to the Internet by either a leased circuit, a telephone circuit or an ISDN circuit.

6. Outline of Demonstrative Experiment

The six target experiment items set for this demonstrative experiment are described hereunder.

(1) Online Test Application Processing Work

Regarding this item, the monitors of individual examination applicants and the monitors of group examination applicants conducted simulated experiments on the hypothetical businesses concerned, in connection with "application acceptance confirmation notification service," "cancel treatment service" and "application registration contents alteration and revision services" with respect to tests for information processing technicians and tests for personal computer utilization technicians, for the cases in which the Electronic Authentication System was used and not used. This was to confirm whether or not the Electronic Authentication System was effective in the business operations concerned, as judged from the reliabilities and conveniences of the applicants and from the system's effectiveness in coping with problems. Also, in these business operations concerned, the cases of non-delivery of application acceptance confirmation notification and application cancellation by persons pretending to be the rightful applicants were generated hypothetically in the normally running system to confirm the trouble-shooting performance.

(2) Notary Public Document Submitting Work

Concerning this item, the effectiveness of the Electric Authentication System was assessed in the business operations concerned by conducting experiments on actual applications and notifications in parallel with hypothetic electronic applications and notifications, with the applicants including the applicant, a representative or government organizations concerned engaging in operations in connection with the "applicant dispatching system," "status control system" and "result notification document delivery system." In the business operations concerned, the target applications included agricultural land utilization permit applications, industrial waste collection and conveyance permit applications, resident card copying applications and construction permit applications, in order to encompass a broad scope of business operations including notification, application, continuous application, parallel application and their revisions.

The "application document delivery system" refers to the method of divided dispatching of large-capacity documents and the method of attaching photographs, also the work of handling the application document image format and the handling of external characters, while the "status control system" refers to the work of describing the process of application and its scrutiny to related applicants through the Internet. The "result notifications sheet delivery system" involves the work of notifying the results of scrutinies through electronic data transmission systems with due thought given to the difference with conventional types of media.

(3) Sales Work through Outdoor Terminals without a Store

This demonstrative experiment involved experiments conducted by monitors of domestic users, monitors of foreign users and commodity supply and delivery enterprises, in the event of online shopping services utilizing multimedia kiosk terminals (referred to as MMK), on cases in which the Electronic Authentication System is used or not used. The objective is to verify the effectiveness of the Electronic Authentication System in these business operations concerned, with the purposes of consumer protection and improved renovation of the commodity distribution mechanism. In these business operations concerned, irregularities were generated hypothetically, in connection with commodity non-delivery to procurers, commodity delivery subsequent to cancellation of order, also in connection with cooling-off, toassess the problem disposition attributes.

(4) Antiquarian Book Selling Work

Regarding this demonstrative item, the monitoring members, members in general, approval organizations and antiquarian book proprietors participating in the experiment conducted experiments on the operations comprising this business concerned, such as "book affirmation work," "member administration work," order re-

ceiving and dispatching administrative work" and "ledger administration work" on cases in which the Electronic Authentication System was used or not used, to corroborate the effectiveness of the Electronic Authentication System in these work operations concerned.

(5) Electronic Publications Copyright Control Work

For this demonstrative experiment item, experiments were conducted by writers, publishing companies, publishing organizations and experiment monitors in connection with diverse business operations comprising the business operations concerned, such as "work to preserve electronic publications and electronic publishing contracts," copyright administrative work," "publications possession right administrative work" and "permission of use contract preservation work" which comprise the business work concerned, on cases in which the Electronic Authentication System was used or not used, to corroborate the effectiveness of the Electronic Authentication System in these work operations concerned.

(6) Electronic Authentication System Service Charge and Charge Rate

Regarding this demonstrative experiment item, various costs were compared, such as the initial cost and running cost of the Electronic Authentication System computed by management, the initial and running cost relating to the establishment of a business provided system when the respective Business Service Provider utilize the Electronic Authentication System as a means to cope with problems relating to electronic commerce as in connection with "actions carried out in pretense of genuine users," and the alternative costs incurred when some trouble countermeasure was adopted in place of the Electronic Authentication System, in order to compute the proper service charge for Business Service Provider. Also, various patterns for the charge rate system for this service charge were studied, such as the meter-rate, fixed rate system and combination system, to evaluate the appropriateness of the service charge system.

7. Review and Study of Experiment Results

The results of demonstrative experiments of the six items were reviewed and studied as described here.

(1) Online Test Application Processing Work

The Electronic Authentication System was confirmed to be generally effective in connection with applicant reliability, applicant convenience and running efficiency of management, which were selected for study in connection with this demonstrative experiment item. Meriting special mention was the tremendous interest was shown in the Electronic Authentication System in connection with the "function to certify application facts as a third-person organization" and the "time stamp function" of postmarking, which post offices are performing as a part of their routine business operations in the handling of postal money orders.

However, the results failed to live up to expectations regarding the excellence in coping with problems, an aspect in which the excellence of the Electronic Authentication System had been anticipated most of all in the business operations concerned. The main causes were observed as having been the lack of recognition of the concept and significance of the Electronic Authentication System on the open network system by the monitors participating in the tests.

(2) Notary Public Document Submitting Work

Regarding this demonstrative experiment item, the effectiveness of the Electronic Authentication System was fully confirmed as anticipated regarding the simplification and shortening of application and notification procedures as well as in connection with the optimization of work relating to electronic result notification, specifically in connection with the system of handling electronic applications, status administration system and the system of dispatching result notifications. Deserving special mention is the excellent evaluation obtained from applicant representatives and governmental organizations concerned who actually make applications and notifications with respect to both electronic applications handling systems. Also, legal experts considered that the electronic result notification system is amply applicable under the existing legal system.

On the other hand, the need for legal and systematic improvements was pointed out in connection with the operabilities of the terminals of applicant representatives and governmental organizations, also the need for supplementation of status information, primarily in connection with the technical issues supporting the business operations concerned, the interpretation of the initial certification and application/notification arrival principle in the sectors of electronic applications and notifications, and the genuineness of assurance relating to electronic certificates and permits.

Demonstrative Experiment of Electronic Authentication System

(3) Sales Work Through Outdoor Terminals without a store

Regarding this demonstrative experiment item, one of whose main themes had consisted of consumer protection, concern remained in connection with the technical reliance and the efficiency relating to the solution of problems, but the Electronic Authentication System's effectiveness was confirmed in connection with commodity misdelivery to consumers, inadequate reflection of contents of ordered commodities, inadequate reflection of order cancellation and inadequate cooling-off time when problems occurred. Also, as the secondary effect, generally good evaluation was acquired and new expectations were raised on the electronic authentication system in that it offers a sense of trustworthiness to commodity suppliers.

(4) Antiquarian Book Selling Work

In all the themes scheduled for experiment regarding this demonstrative experiment item, anxiety was raised regarding the technical reliance and stability in connection with the Electronic Authentication System's disposition speed and problem solution efficiency, while inconveniences were also pointed out in connection with the Electronic Authentication System's client software, such as the inadequate interface affinity and operational ease, with the result that technical problems had adverse influences in the setting of the demonstrative experiment items.

	Type A	Type B	Type C
Membership fee	¥ 0	¥ 3,000	¥ 8,877
File capacity	50KB		
Duration	1,000 days		
Connection mode	OCN		
Time band	Weekday and nighttime		

Table 2. Setting of types of service charge systems

Service Name	Model Charge Rate		
	TypeA	Type B	Type C
Registration	2.5	1.7	0.0
Additional registration	2.5	1.7	0.0
Registration card delivery (simple)	3.8	25	0.0
Registration card delivery (registered)	6.3	4.1	0.0
Additional registration card delivery (simple)	3.8	2.5	0.0
Additional registration card delivery (registered)	6.3	4.1	0.0
Delivery (simple)	2.5	1.7	0.0
Delivery (registered)	5.0	3.3	0.0
Opening notificati story inquiry	3,579.4	2,369.7	0.0
Personal information inquiry	3,579.4	2,369.7	0.0
Certificate issuance	5,369.1	3,554.5	0.0
Affirmation (or non-affirmation)	2.5	1.7	0.0
User offline registration	2.5	1.7	0.0
User online registration	2.5	1.7	0.0
Personal information correction	2.5	1.7	0.0

Table 3. Service charge rates for various charge systems

(5) Electronic Publications Copyright Control Work

Regarding this demonstrative experiment item, technical issues were raised in connection with the efficiency and stability of conducting business operations by management, but this was because the business operations using the Electronic Authentication System were not carried out regularly during the period of demonstrative experiment, or applied only in limited, extremely short periods.

On the other hand, there was a clear indication that the monitors of copyright, publication possession organizations, publishing enterprises and consumers are di-

recting attention on the sense of utilization and sense of anxiety in connection with business services rather than on the technical reliability and stability. Users were more concerned about human errors such as electronic copyright tampering and theft rather than on the technical reliance and stability of the business operations concerned, including the Electronic Authentication System, so the anxiety was displayed in connection with the business operation that cannot be realized simply by coping with technical matters.

However, copywriters, publication organizations, and monitors and consumers who are the actual recipients of convenience, are looking forward to the establishment of sales channels for new publications based on the protection of copyright and other rights, and a highly interesting result was obtained that the copywriters and publication organizations which are faced with diverse uncertainty factors, in particular, are sensing the urgent need for establishing a sound authentication system.

(6) Electronic Authentication System Service Charge and Charge Rate

It is quite significant that the benefits of the Electronic Authentication System were confirmed despite the fact that there were restrictive utilization conditions regarding the five business operations in connection with this demonstrative experiment. Regarding this demonstrative experiment, the difference between the hypothetic coefficient of expenditures set in the initial stage and the coefficient of expenditures set for the business applications by taking the state of utilization into account was much greater than initially estimated since the frequency of utilization of the Electronic Authentication System far exceeded that expected at the initial stage.

Also, generally good results were also indicated in connection with the acceptance of the Electronic Authentication System as a means to cope with hazards by business managements, so good results were obtained on the expectations placed on the Electronic Authentication System, including the results suggesting the possibility of decreasing business costs. In view of these conditions, the service charge system (see Tables 2 and 3) which set the respective service charge rates, meter-rate system, fixed charge system and combination system based on the profitability indicated by the good results of this demonstrative authentication experiments and the appropriateness of the coefficient of expenditures corrected on the basis of this profitability, may be evaluated as applicable commercially in view of the acceptance by many users of the Electronic Authentication System.. Therefore, the conclusion is that the propriety of this service charge system and charge rate system set through this demonstrative experiment item have been fully confirmed.

8. Summary

This demonstrative authentication experiment corroborated that the Electronic Authentication System is effective and therefore that users can be assured with respect to the hazards arising in commerce via the Internet and open network systems, as in connection with "engaging in transactions and settlements in pretense of the genuine parties," "the alteration of transaction facts as through the alteration and omission of electronic information contents exchanged between transacting parties," and "denial of business transaction facts subsequent to the conclusion of contacts." The appropriateness was also confirmed of the service charge system and charge rate system of the services supplied by the Electronic Authentication System, which were simulated on the basis of the actual state of utilization of diverse business applications through this demonstrative authentication experiment.

On the other hand, several disadvantages have been pointed out in the Electronic Authentication System designed, developed and operated in this demonstrative experiment, such as slow processing speed, high degree of obstacle generation, and ambiguity in the target security evaluation standards, with the result that many technical matters still remain to be resolved in order to increase the reliability and stability of this technology.

Henceforth, in view of the great expectations to be placed on the electronic authentication system's contribution to the establishment of sound and safe open market, of which the targets and scale are certain to undergo substantial expansion in the years ahead in connection with electronic commerce utilizing open networks, it will be quite important to devise and carry out measures which would further advance the elementary technologies and management control functions of the electronic authentication system .

Experiment on Secure Electronic Storage System for Certified Original

Masahiro Yamaguchi
Associate Professor,
Imaging Science and Engineering Laboratory,
Tokyo Institute of Technology

1. Introduction

The utilization of information systems is proceeding rapidly in various fields such as electronic commerce, health care, etc., and the storage of the documents whose preservation is mandated by statute is impressing a heavy burden on enterprises. Therefore, the realization of the electronic preservation of documents is strongly expected for the efficient business as well as for the reduction of storage costs.

The "Advanced Information and Communication Society Promotion Headquarters" and the "Working Party for Review of Institutions and Systems" established by the Cabinet studied these matters from the aspect of decreasing the social cost and improving the efficiencies of administrative processing. A conclusion of their investigation is to recognize the electronic preservation of documents in principle. It also points out that it is compulsory to secure the data genuineness, readability and preservability.

The "Secure Electronic Storage System for Certified Original" or "Electronic Safety Box" was proposed under above background, to enable the electronic preservation of documents and to promote paper less way to deal with the accounting ledgers, tax recordings, applications, reports, etc. The project to develop the "Secure Electronic Storage System for Certified Original" was carried out in FY 1997 by the New Media Development Association conducted under the Advanced Software Enrichment Project of Information-technology Promotion Agency, Japan (IPA).

In this paper, the concept of the "Secure Electronic Storage System for Certified Original" and the overview of the developed system are given.

2. Concept of the "Secure Electronic Storage System for Certified Original"

(1) Requirements for the Electronic Storage

Recent progress and popularization of the information systems are strongly due to the utilization of digital technology. The digital technology enables us to share the identical data through networks or storage media, but it also give rise to new problems because it is very easy to copy or alter digital information.

According to the report issued by the Working Party for Review of Institutions and Systems, securing the genuineness, readability and preservability of data are necessary to allow the electronic storage of documents to be requiring preservation, and the enhancement of the probative value as an evidence is also required. In general, data genuineness, readability and preservability are secured by appropriately combining technological, institutional, systematic measures.

Although all types of hazards are covered by the aforementioned countermeasures in the conventional system of document preservation in the form of papers or films, new hazards arise when engaging in electronic preservation. Appropriate measures must be devised to certify that the stored information is the original and has not been altered.

In the electronic notary system, the stored data are certified to be unaltered by a trusted third party, namely, the requirements for electronic preservation are satisfied by devising the institutional and systematic measures. Meanwhile, by developing new electronic storage system having the functions equivalent to the papers or films, it is also possible to devise the technical measures with respect to new hazards which arise when engaging in electronic preservation. In this case, there will be no need to change conventional document management systems or to establish new regulations and monitoring system. Therefore, it is comparatively easy to implement the electronic storage of the documents requiring the preservation.

The Secure Electronic Storage System for Certified Original has been developed with the aim of satisfying aforementioned technical requirements by incorporating a mechanism to physically and logically maintain the security of stored information.

(2) Method of Protecting the Original

In the Secure Electronic Storage System for Certified Original, the stored information is secured by physical and logical protection against unauthorized access. The methods for protection are summarized hereunder;

1) All access to the memory (ex. Read/Write) is controlled by the central processing unit (CPU).

2) Access to the storage device is restricted to only the standard input/output (I/O) port.

3) The storage device is packaged to inhibit component replacement or data alteration.

4) The control program is stored in a ROM unit to render tampering impossible.

Fig.1 shows the basic construction of the storage system featuring these functions. Above functions are equivalent to those of a smart IC card, which is coming into wide use recently, and the data stored in the system is only accessed by a method prescribed by the control program. This control program prohibits the alteration of stored original data, so that the following functions are realized (see fig.2);

* Since the access to the system is restricted through the standard I/O port, the readability is achieved regardless of the type of storage medium.

* The erasure and the alteration of data stored as the original are prevented. Whenever an unauthorized entry is attempted by breaking the package physically, the trace of unauthorized access is recorded. (tamper-resistance or tamper-evidence) By implementing these functions, it becomes possible to secure the genuineness, readability and preservability that are almost equivalent to the conventional system using papers. Also, the access logs are recorded to improve the probative value of the stored data. Considering the practical use of the system, this system can be used to store the data files other than the original. Accordingly, four kinds of information status are defined; provisional original, authorized original, authorized copy and not specified, as described in section (4). By controlling the access rights

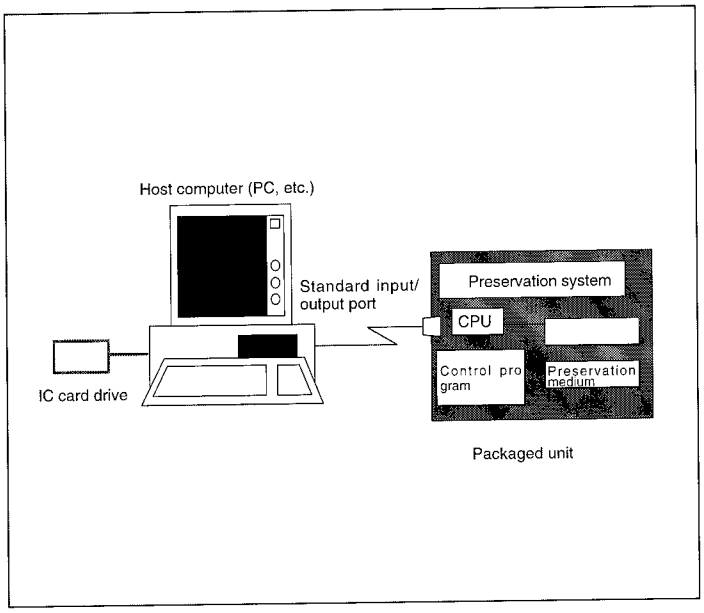


Fig. 1. Conceptual diagram of original text nature protection electronic

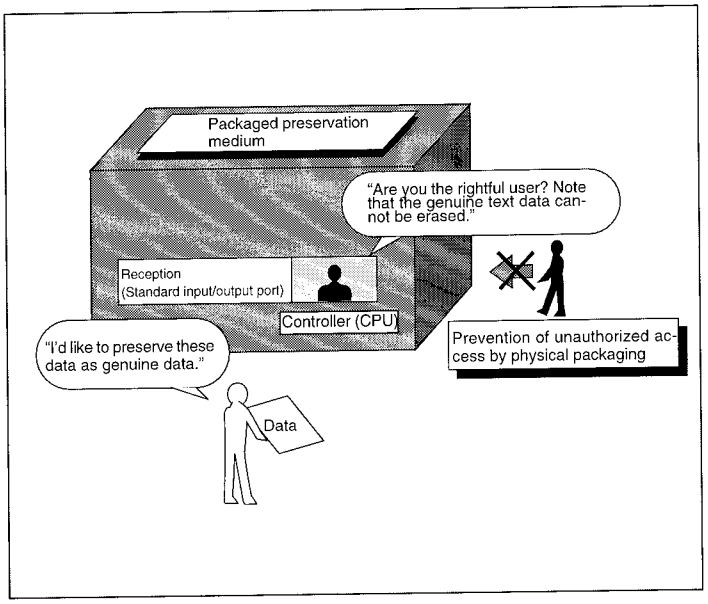


Fig. 2. Original text nature protection by certification function

to the stored files based on the status, the distinction of the original and copy becomes possible. This file status management is basically the same as the method adopted by the Common Standard for Electronic Storage of Medical Image Files published by Medical Information System Development Center (MEDIS-DC).

3. The developed prototype

(1) Outline

The developed system consists of the storage device and the host computer as shown in Fig.3. The storage device is available in the forms of both unitized systems such as hard disks and removable systems, for example, CD-R and magneto-optical disks (MOD). Although the method for the physical and logical packaging depends on the unitized type and the removable type (see section 2), the host computer recognizes them as identical devices except for the memory size.

A versatile type PC is used as the host system, which manage the user request and process the I/O to the storage device. In this system, the interface between the storage device and host computer (standard I/O port specifications) is designed with rigid specifications, though the standardization is required, and can therefore be utilized by not only the PC used in the prototype but also any type of host computers.

Experiment on Secure Electronic Storage System for Certified Original

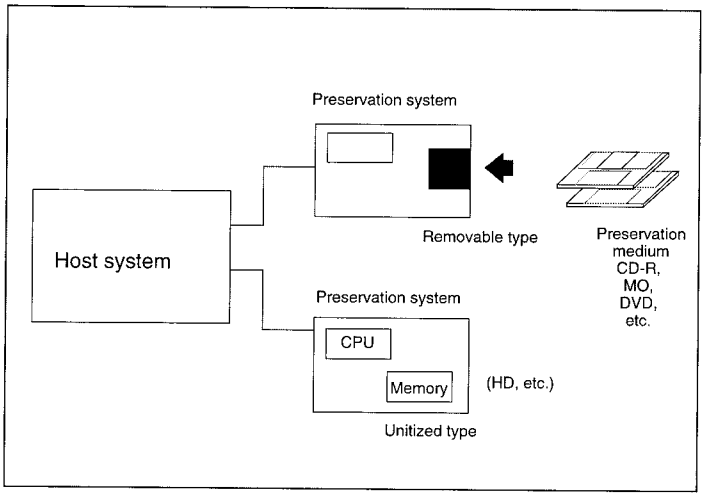


Fig. 3. Basic construction of newly developed system

(2) Packaging

Let us consider the unitized-type storage device. It is necessary to package the storage device so as to protect against unauthorized physical access; direct access into the memory and any change of the control program. In the prototype developed this time, physical packaging was not implemented because the target of the project is to cope with above types of attacks is necessary for commercialization. In addition, the communications between the storage device and host computer is limited to only the I/O port as described in section (3).

Next, to use a removable storage medium such as an optical disk, there arises the possibility of alteration by some other systems. To cope with this type of problem, logical packaging, that is the each medium is individually managed by giving the identification (ID) number and the message authentication is attached to the stored data. The ID number and the message authentication code (MAC) are kept in the local memory of the storage device, and are protected against unauthorized use and alteration. Namely, the data in the removable medium is attributed to corresponding storage device, and any change of data by the other system is detected by the verification of the ID number and MAC. Although logical packaging is realized by this kind of approach, the complete prevention of the erasure or the alteration is not possible if conventional versatile media are used, and it should be noted that the slight reduction of security level is difficult to be avoided if compared with the unitized-type storage device.

Incidentally, the current prototype can use the MOD conforming to the common standard for medical image storage as well as CD-R as the removable medium, despite that the storage system can be realized independent on the type of the storage media. If using the common standard MOD, unauthorized access is extremely difficult, because it has the security mechanism that prevents the access with an ordinary MOD drive.

(3) Data Input/Output

The contents of stored data can be read by displaying them on the monitor of the host computer or making a hard copy by the printer. To secure the readability of the stored original data, it is necessary to guarantee that the same results would be obtained even if the data are displayed by various different host systems. For this purpose, the specification of the data I/O port is strictly defined, while the lower layer protocol are not so that it is possible to select an existing communication interface in conformance with the type of the hardware, such as TCP/IP, SCSI, and RS232C.

In the communication between the host computer and the storage device, a "command" conforming to the required operation is transmitted to the storage system. All the functions of the storage system are defined by the commands, such as "create file," "read data" and "write data." The results are displayed as "response" from the storage system, and whenever a undefined or non-permitted command was received, an "error" response is returned.

(4) File status control

As described before, since files other than the original data are also stored in this system, following four types of file status are defined to control the file access, for the purpose to discriminate the original and others and to guarantee the uniqueness of the original information:

1) Provisional Original

This type of status is given to the files which have the possibility of the preservation to be required. This type of file can be deleted, but alterations other than the additions are prohibited.

2) Authorized Original

Files whose preservation is mandated by statute have this type of status. Alteration other than additions, also erasure, are prohibited.

3) Authorized Copy

This expresses that the file is an attested copy of the authorized original. Any access except for readout is prohibited to prevent the tampering.

4) Not Specified

Not Specified type is given to the files which are not given access control. All kinds of access such as read, write, erasure and others are permitted. The change of file status is limited to the directions indicated in Fig.4, so that it is impossible to alter an original file or replace an Authorized Original with a Not Specified file. Also, the transcript can be produced from the original file, and the original can be distinguished from the copies as well. In addition, the authorized original is produced only from the provisional original, so as to keep the confidence of the original file, by limiting the generation of the original file to specific persons or systems having the right to generate the provisional original files. For example, regarding the electronic storage of medical images, only the images originated by the authorized imaging apparatus have the status of provisional original.

Although rewriting the original file is prohibited as a means to prevent original file tampering, there may be a need to make additions or revisions to the original files. Therefore, this system provide a function to enable appending new data into authorized or provisional original files. In this case, appended date/time and history are saved as well as all the appended data, and the probative value of stored data is still retained. It should be noted that the management of appended data, such as specifying the edited part of data, are to be done by an application program.

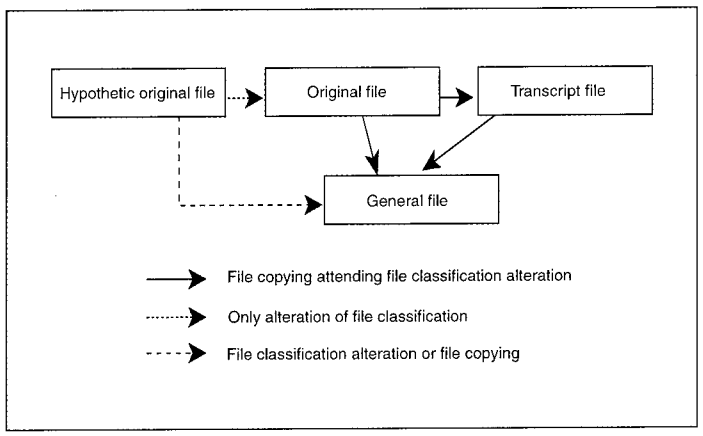


Fig. 4. File classification alteration regulations

(5) Recording Access Log

In this system the access log to the storage device is recorded, to increase the probative value of stored data. The access date/time and the access type such as write, append or change of file status, are automatically recorded in the storage device. When several persons use the storage system, the log includes the information that identifies the individual who accessed to the system. A timer built into the storage system is used to specify the date/time of access.

Moreover, the history of the system administration (see section (9)), such as the registration of users and timer setting is also recorded. Accordingly, even if the administrator's rights were fraudulently used and an attempt made, for example, to change the timer setting to tamper with past data, the traces of the attempt is recorded. Furthermore the recorded log information cannot be removed even by the administrator, as with the authorized original file. Incidentally, the recording of access log is conceived to be effective for suppressing fraudulent actions.

(6) User Identification

When this system is connected to the network and employed by several users, the function to identify the individual user can be utilized so as to make the system administration easier. The key information of each user is securely registered in the storage device, and the user is identified by the authentication between the smart IC card possessed by each user and the storage device. Using this identification, the access control depending on each user and the recording of the user identification to the log become possible.

(7) Copy and Move of Original File

To certify the original data even when the original data is copied or moved between the storage devices through a network, the functions of "Copy" and "Move" of original file are incorporated in this system. The copy created in another device has the authorized copy status. When an original file is moved to another storage device, the data in the source storage device is removed and the new file in the destination becomes the original. To guarantee that these functions are only performed between the valid storage devices, the validity of the storage systems are confirmed by the mutual authentication. The data integrity during the copy or move is also assured by message authentication.

Experiment on Secure Electronic Storage System for Certified Original

(8) Backup of Original File

Though the preservability of the stored data depends on the performance of each recording medium used in the storage device. In the system developed this time, the automatic backup function is implemented to increase the data preservability. As the method of securing the data preservability is realized through internal processing and does not affect the external interface, arbitrary method can be applied. In the developed prototype, the original data can be recovered from the backup data, which is automatically generated in the storage device, even from the damage that cannot be corrected by the error recovery function of the recording medium.

(9) Administration of Storage Device

The administration of the storage device such as the user registration or timer setting can be performed only by an authorized administrator. After the verification of authorized administrator using a smart IC card, the administrative functions become effective. The history of the administrative operation is also recorded in a log, which cannot be removed or altered even by the administrator.

(10) Data Format

Standard data format is necessary to keep the readability of the stored information. Standardization is a future task, and we assume following two types of data formats.

a) Common Format suitable for accounting

The data format enabling the reproduction of the style of ledgers, invoice, and other accounting forms is defined as "Common Format." The image of the forms including ruled lines can be easily reconstructed from the data described by tagged text format.

b) Common Standard for Electronic Storage of Medical Image Files

The data format and the MOD defined in the Common Standard published by MEDIS-DC is used for the storage of medical images, so as to keep the consistency with the existing systems for medical image storage.

4. Implementations and Applications

The implementation of this system has large variations, from compact, handy and portable system to a large-capacity file server, because only the specifi-

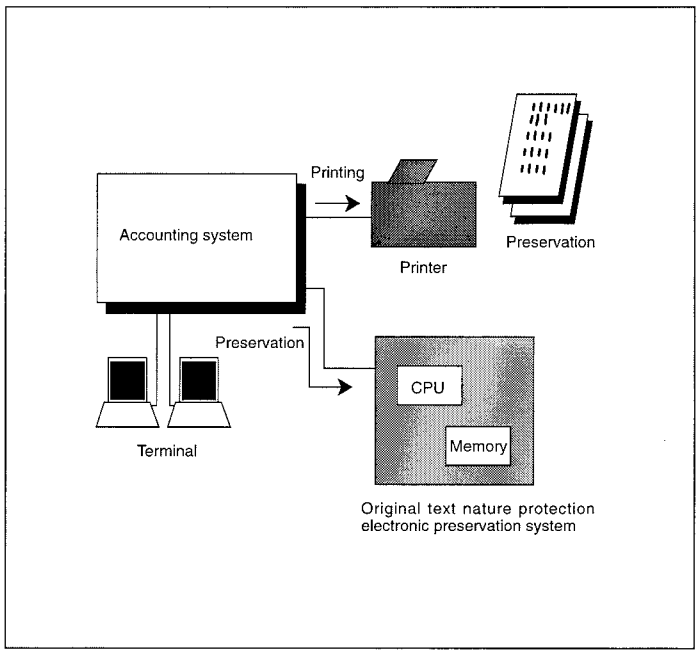


Fig. 5. Image of system utilization by local interconnection.

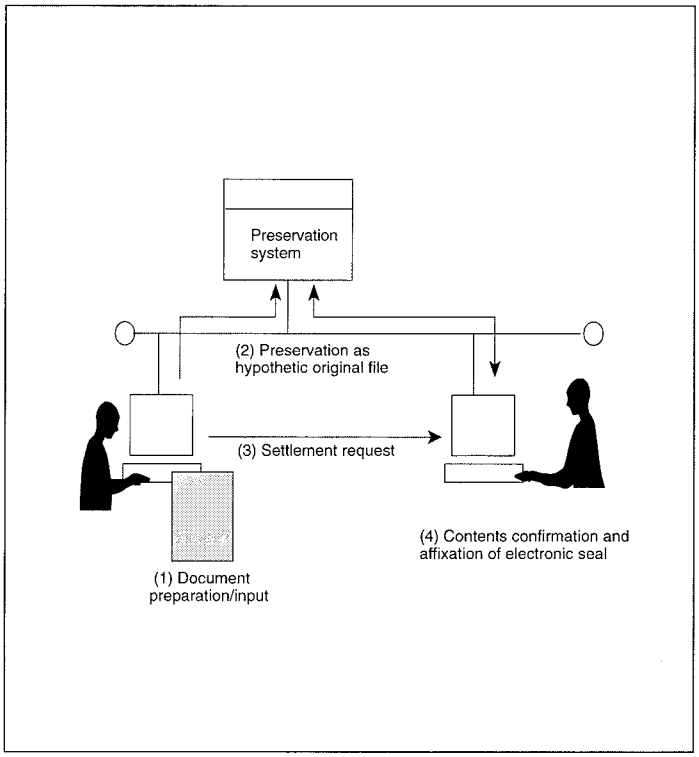


Fig. 6. Image of system utilization on LAN system

cation of the I/O interface have to be designated and the type and capacity of memory or CPU are not restricted. Arbitrary type of recording medium can be used, moreover, and it will be possible to utilize this system as a versatile-type secure electronic storage system. Fig.5 and Fig.6 indicate the examples of expected application of this system. In Fig.6, this system is used as a peripheral of host computer system just like a printer, which is conventionally used for the output of documents to be preserved. It is easy to replace the conventional method of document output with a printer by that using the electronic storage system, resulting in the efficiency being improved in the retrieval and reuse of the stored data, as well as space savings. It is also possible to use this system with LAN or Interanet as shown in Fig.6.

Here the storage device is directly connected to the network and the users having access to the network can use the device. Specifically, by utilizing a software for electronic signature or seal ("inkan" in Japanese) and the function of this system for appending data into the original file, one can impress an electronic seal on an original document generated by oneself or another user through the network.

5. Future Task

Though only the minimum functions were implemented in this project, following problems remains to be resolved.

* Physical packaging

It is necessary to install a tamper-free mechanism to cope with unauthorized physical access.

* Standardization of I/O command and communication protocol

It is necessary to lay down and publicize the standard specifications of I/O command and communication protocol, based on those implemented in this prototype.

* Data Format

Data format suitable for various class of application fields should be investigated to secure the data readability. In addition, incorporating more sophisticated functions listed as follows is expected to expand the substantial application areas.

* Management of users and other storage devices through network including authentication keys.

* Electronic signatures or electronic seal (inkan).

* File retrieval for the reutilization of stored data.

* The certification of dispatch and arrival of messages such as e-mail.

* Application to a secure file-server

It is also necessary to conduct feasibility studies to corroborate the validity and the effectiveness of this system, as well as to establish the specifications.

6. Conclusion

The system developed in this project alleviates the requirements to the systematic countermeasures against the hazards that appear in the digital storage of original documents, by employing technical countermeasures such as the protection against tampering. Therefore the introduction of the electronic storage is relatively easy without establishing social system for administration. This system will likewise beneficial for the electronic data storage in Electronic Notary Centers and Certificate Authorities. Studies are currently given to the use of WORM (write one read many) storage media such as CD-R for this kind of applications, but it should be noted that even WORM does not guarantee the prevention against alteration. On the other hand, the Secure Electronic Storage System for Certified Original certifies the original documents regardless of the type of storage medium, by the physical and logical tamper-resistant or tamper-evident mechanisms. Therefore each user can flexibly select optimal type of storage medium suitable for one's application field considering the technological level and the cost-performance.

Furthermore, this system has the advantage at the point that the system is capable of coping with future technical innovation. In view of the increasingly stringent demands for the electronic preservation of documents, it is anticipated to resolve the problems pointed out in preceding chapter 5, also to demonstrate the effectiveness of the system through field tests, and to enable practical use as soon as possible.

NEW TECHNOLOGY & PRODUCTS

This section provides information about recently developed technologies and products, divided into Advanced Materials, Electronics & Optics, Information & Communications, Process & Production Engineering, Construction & Transportation, Energy, Environment, and Biotechnology & Medical Science.

Advanced Materials

98-06-001-01

First PcTiO Discotic Liquid Crystal Synthesized

The Osaka National Industrial Research Institute of AIST-MITI has succeeded in synthesizing the first phthalocyaninato-oxotitanium (PcTiO) discotic liquid crystal as a novel photoconductive liquid crystal. PcTiO is one of the most interesting photoresponsive materials because of their high photoconductivity, and have potential uses in xerographic photoreceptors and GaAsAl printers. Many studies of the solid state film show that the charge generation

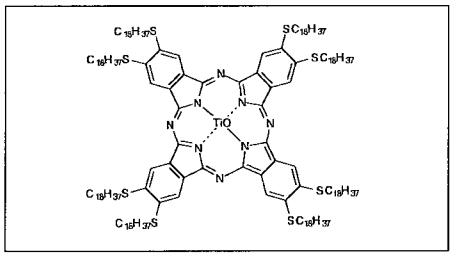


Fig.1 Photoconductive metallomesogen: octasubstituted oxotitanium phthalocyanine

efficiency of PcTiO derivatives is strongly dependent on the crystal structure. The photoconductivity of discotic crystals has been studied extensively. In particular, a fast hole mobility (0.1 cm^2V-1s-1) was reported for a plastic crystalline phase of a triphenylene discotic liquid crystal. However, no study of liquid crystalline PcTiO derivatives has been performed. Therefore, studies of the charge carrier generation process as well as the determination of the charge carrier mobility in the liquid crystalline phase of PcTiO derivatives are expected to provide important information regarding applications. The thermal behavior of 2,3,9,10,16,17,23,24-octakis (octadecylthio)phthalocyaninatoozotitanium (IV) was investigated by polarized light microscopy, differential scanning calorimetry (DSC) and X-ray diffraction, revealing that two hexagonal columnar mesophases are formed.

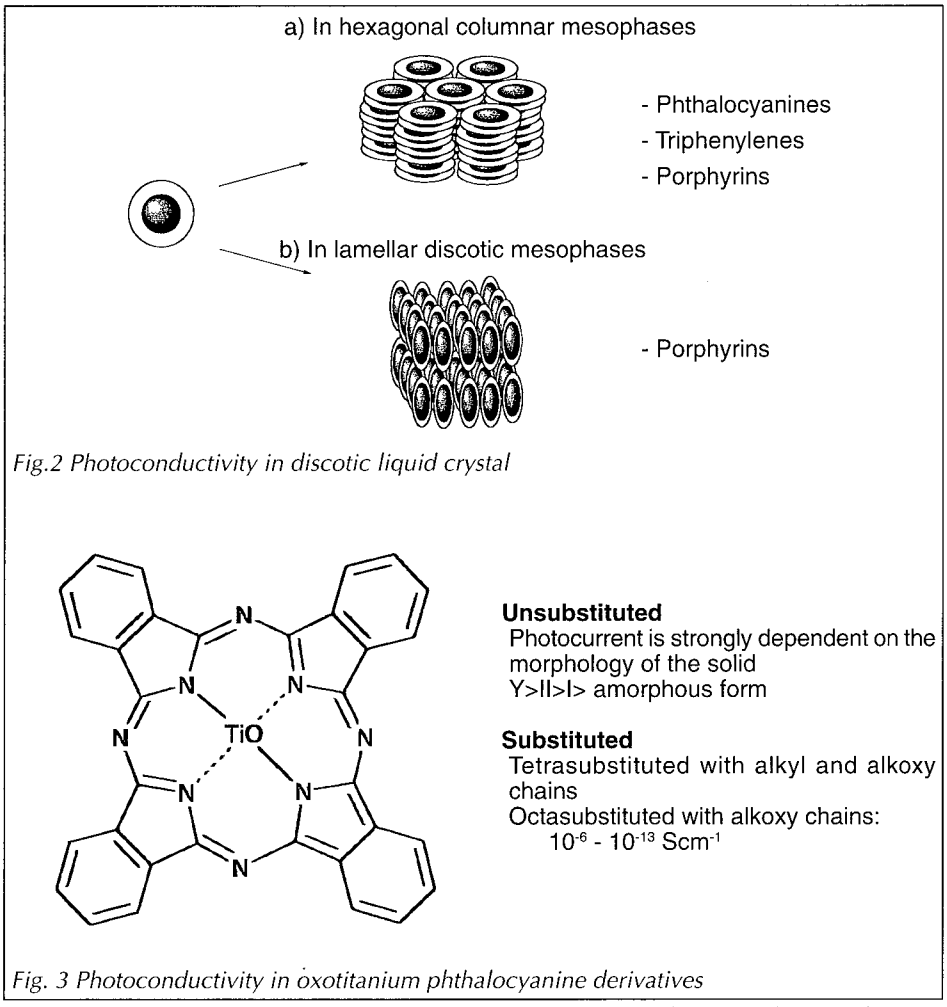


Fig.2 Photoconductivity in discotic liquid crystal

Fig. 3 Photoconductivity in oxotitanium phthalocyanine derivatives

* ***Osaka National Industrial Research Institute, AIST, MITI Organic***
Functional Materials Dept.
1-8-31, Midorigaoka, Ikeda City, Osaka 563-0026
Tel: +81-727-51-9628
Fax: +81-727-51-9523

Electronics & Optics

98-06-002-01
Fail-Safe Thin Film Current Sensor Using Flux Saturable Ring Core

Prof. M. Yamaguchi of the Research Institute of Electrical Communication, Tohoku University has developed one chip size fail-safe thin-film current sensors using a flux saturable ring core based on photo fabrication technology with cooperation of Shimadzu Corp. to cope with the needs for highly reliable miniature over-current sensors to drive over-current relays.

The newly developed sensor consists of a transformer unit composed of a CoZrNb ring core, primary and secondary coils made of Cu thin-film, and a load coil which surrounds the transformer unit (Fig.1). An important technical issue is to align the hard axis of magnetization of magnetic film along the circumferential direction for high-frequency use, and this was solved by using Co-base amorphous thin-film with rotational magnetic field annealing. The design criteria was to match the flux saturating magnetic field with the threshold over-current level, so design was based on new thin-film core analysis.

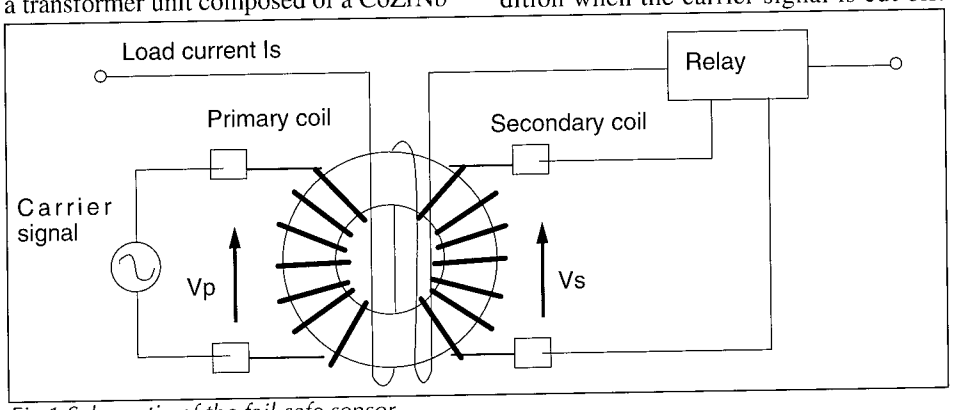


Fig.1 Schematic of the fail-safe sensor

A high frequency carrier signal passes through the transformer unit in the normal state, but the carrier signal is cut off in the over-current state because the m.m.f. from the load coil saturates the transformer core locally at the load coil region. The relay connected to the thin-film secondary coil recognizes that the system is normal when the carrier signal is received by the relay. The system senses an abnormal signal condition when the carrier signal is cut off. Moreover, if the carrier signal is turned off by a system accident (not over-current, e.g., the sensor chip broken), the relay can also recognize that this is an accident. The signal isolation capability at the transformer unit is also a required feature for a reliable system. Thus the fail-safe over-current protection system was developed. The chip size of newly developed sensor is 4 mm × 4 mm. A transmission efficiency of 60% was obtained when the carrier signal was 3Vpp-1MHz sine wave. The secondary voltage of the sensor successfully dropped by 90% when a 100 mA load current was applied to 20-turn load coil. This sensor is expected to encourage the use of functional thin-film electromagnetic devices.

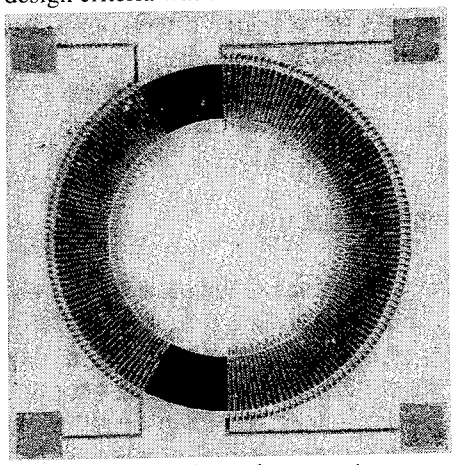


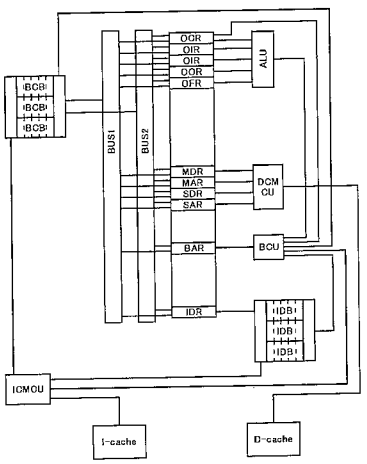
Photo: Completed transformer unit

* ***Tohoku University***
Research Institute of Electrical Communication, Spin Electronics Research Division
2-1-1, Katahira, Aoba-ku, Sendai City, Miyagi Pref. 980-8577
Tel: +81-22-217-5488
Fax: +81-22-217-5489
E-mail: yamaguti@riec.tohoku.ac.jp

98-06-002-02
Bus Instruction Set Computer

Y. Yamashita and his research team of the Department of International Development Engineering, Faculty of Engineering, Tokyo Institute of Technology, have devised and established the logical design of a new type of processor, the Bus Instruction Set Computer (BISC), featuring high-speed processing and functions can be added with ease.

The architectures of microprocessors in ordinary use today are the CISC, RISC and VLIW versions. The working speeds of these architectures are being increased by pipelines, superscalers, branching estimation and instruction reordering. However, introducing these functions makes the processors increasingly complicated, so it is actually difficult to make additional changes in processor functions in response to needs. The BISC architecture was devised to cope with this situation, and a BISC-1 processor is being fabricated based on this design.



ALU	Arithmetic logic unit
BAR	Branch address register
BCB	Branch control buffer
BCU	Branch control unit
D-cache	Data cache
DCMCU	Data cache memory control unit
I-cache	Instruction cache
ICMCU	Instruction cache memory control unit
IDB	Immediate data buffer
IDR	Immediate data register
MAR	Memory address register
MDR	Memory date register
OCR	Operation control register
OFR	Operation flag register
OIR	Operation input register
OOR	Operration output register
SAR	Stack address register
SDR	Stack data register

In the architecture to issue instructions, when the leading single bit is 1, this indicates that a series of instructions have been completed and will be followed by branching. When the next single bit is 1, this indicates that the next word is not an instruction but an immediate data. After that, the register numbers of the sender and the receiver are aligned in a pair.

For the execution of instructions, the sender register is read out, and when the receiver register can read in, this is achieved by data transfer. For arithmetic or logical processing, a bit of data is transmitted to the register to indicate the type of arithmetic processing to be achieved by the arithmetic logic unit (ALU). In this case, the number of bits necessary for indicating the arithmetic processing is few, so it is possible to indicate several batches of arithmetic processing with a single word. Arithmetic processing is commenced as soon as the necessary volume of data for the ALU input register is transmitted, and the results are read out with the output register.

Regarding branching, a register to set the branching destination address and a register to indicate whether the branching is conditional or non conditional are prepared (with BISC-1, the register surplus bits other than those used to indicate the type of arithmetic processing are used). The conditions for conditional branching are provided in the same manner as for indicating the type of arithmetic processing to the ALU. The information regarding the establishment or non-establishment of the conditions is transmitted to the branching control unit, and branching performed after carrying out the instructions of the leading bit. Based on this branching function, there may be cases in which the branching destination is determined beforehand (as with a looped message), so branching can be achieved efficiently.

This architecture does not require instruction set changing with respect to the additional changing of functions, so various types of functions can be added with ease. In addition, the time for executing an instruction can be shortened to the extent it will be impossible to shorten the time further, so the resources inside the processor can be utilized most efficiently. Further, since the range in which operations must be performed with the same clock frequency is rather narrow, the issue of clock skewing is alleviated. At present, the logical design of BISC-1 with duplicated internal bus has almost been completed, and performance evaluation is presently in progress.

* ***Tokyo Institute of Technology***
Department of International Development Engineering, Faculty of Engineering
2-12-1, Ookayama, Meguro-ku, Tokyo 152-8552
Tel: +81-3-5734-3497
Fax: +81-3-5734-3497
E-mail: yamasita@ide.titech.ac.jp

Machinery & Mechatronics

98-06-003-01

Automatic Workpiece Packing System Preventing Damage to Workpieces

C Dic Co., Ltd. has established an automatic system Soft Hand-a for packing workpieces discharged from the delivery chutes of NC machines into containers. The automated system is for bar feeder type NC machines and is usable even for unmanned nighttime production line operation. It is marketed at a domestic price of ¥650,000. A Soft Hand-b system with automatic container changer has also been developed that is available at a price of ¥1,200,000.

A distinct characteristic of Soft Hand-a and Soft Hand-b is that these systems permit workpiece packing into containers without inflicting any damage to the workpieces. For damage prevention, the catch box to handle the workpieces is made of plastics, and the entire workpiece transfer system also designed to prevent damage to the packed workpieces. Further, the workpieces are accommodated in three places when packing them to prevent accumulation in any specific position, while a number computing system is also applied in this process.The a-type system measures (W)320 × (D)500 × (H)1,510 mm, and the b-type measures (W)590 × (D)560 × (H)1,140 mm, so these systems are designed for substantial space conservation compared with counterparts.

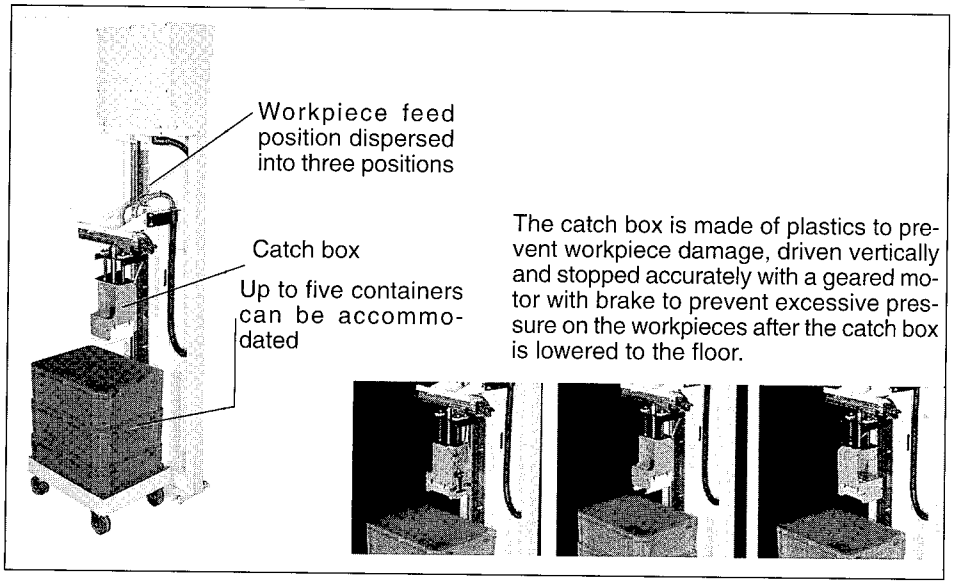
* ***C Dic Co., Ltd.***
48, Miyaura-aza, Machiya, Chiaki-cho, Ichinomiya City, Aichi Pref. 491-0813
Tel: +81-586-77-1233
Fax: +81-586-77-7589

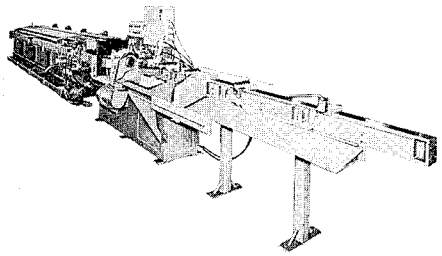
98-06-003-02

Special-Purpose Stainless Steel Pipe Cutter

Matsumura Machinery Mfg. Co., Ltd. has developed a Special-Purpose Stainless Steel Pipe Cutter, Model 90, which can cut pipes with wall thicknesses of up to 3.5 mm and diameters of 50-89.1 mm. Cutting of mild steel pipes is also possible. A standard type of cutter is marketed at a domestic price of ¥15 million.

The new stainless steel pipe cutter is an improved version of the Super Cutter Series Cutters the company marketed in 1995. The cutters in this series cut the pipes by





Special-Purpose Stainless Steel Pipe Cutter

revolving the cutting tools, so the cut faces are neat compared with the use of grindwheels, and hardly any burr is generated. The pipes are fed into the cutting unit without revolving, so there is no hazard of the pipes being deformed by the cutting operations, unnecessary damage to the pipes is prevented, and the cut pipes are not scattered about.

The company's unique characteristic of cutting the pipes while revolving the cutting teeth was reassessed from the outset of designing, and the weight was increased (to about 4 tons) to increase the cutter stability, with the result that hard stainless steel pipes which resist cutting are cut with ease. All cutting and other related operations are controlled with a computer, and any inadvertent operational problem is indicated with a problem indicator. In addition, an inverter-free control method is adopted to set the pipe number of revolutions, so that extra-neat cutting is possible.

* ***Matsumura Machinery Mfg. Co., Ltd.***
135, Ichinokura, Oaza, Nitta-cho, Nitta-gun, Gunma Pref. 370-0306
Tel: +81-276-57-2060
Fax: +81-276-57-2063

Information & Communications

98-06-004-01

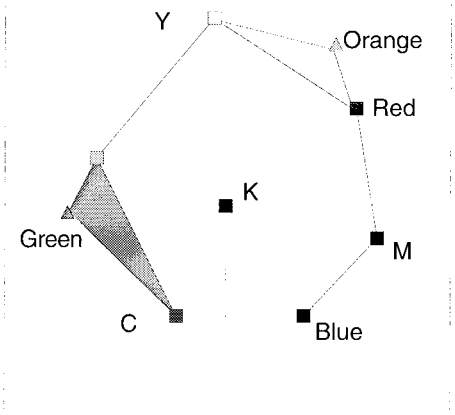
Six Color Ink-Jet Plotter with High Speed Imaging

Mimaki Engineering Co. has developed the first 6 Hi-Fi Color UV resistant 720 dpi piezo plotter.This plotter is designed to reproduce high quality UV resistant images with almost invisible continuous tone standard 720 × 720 dpi dots. By adding orange and green ink to the conventional 4-color process, the color hue is increased. Two parts (green and orange) indicated on the figure could not printed with previous plotters. These areas, which include moss green and fire colors, can be imaged with the 6-color process. Unlike conventional pigment inks, the new 6-color inks have wider color hue and gamut.

The output speed of the new plotter is three times faster than the previous model. For example, an A0 size image can be printed in 11 minutes by high speed mode, 20 minutes by standard mode, and 28 minutes by high quality mode. The fast drying ink does not require any dryer so that the media can be rolled up immediately after printing. Therefore, the image is much safer from possible damages caused by scratches, dust on wet inks. The new plotter is equipped with standard spot color, fluorescent pink.

Other convenient features include head height settings for thicker media such as cloth and canvas, air suction media holding, 128MB buffer, centronics IEEE-1284/ECP mode interface, Ethernet adapter, 1,220 cm^3 ink cartridge, multilingual LCD, WinLink 95 (Rip for Windows 95), etc.

Furthermore, the new plotter has the following advantages: Wide color gamut of orange, green, yellow, magenta, cyan, black, and pigmented inks setting a new industry standard, unattached high quality printing is achieved by automatic take-up devices, fast drying inks, and newly designed drive mechanism, and convenient features for production: 7 heads, head height adjustment, and maximum 1,320 mm (52 inches) print area.



Imaging area of newly developed 6-color ink-jet plotter

Full color piezoelectric ink-jet plotter

* ***Mimaki Engineering Co., Ltd.***
International Sales Dept.
TKB Gotenyama Bldg., 5-9-41, Kita-Shinagawa, Shinagawa-ku, Tokyo 141-0001
Tel: +81-3-5420-8671
Fax: +81-3-5420-8687

98-06-004-02

Automatic Voice Answering System Suitable for WAN System

Future'z Co., Ltd. has developed automatic voice answering devices for wide-area-network (WAN) systems. The new system is capable of integrated management of received data files sent from automatic voice answering devices installed nationwide in real time by only the system attached to one server installed in the center. Previously, the data received at each automatic voice answering devices could not transmitted directly to the server because the data must be stored temporary in each device.

The new system consists of the server and 4-line automatic voice answering devices, and price is ¥1,980,000. Client information received by each automatic voice answering device can be converted to text, and collected and processed at the server in real time. Furthermore, the system can retransmit the received client information to operators in other channels. This system has the network expansion function, so networks can be easily established with linking between the database and information receiving base. The new system is suitable for telemarketing, direct marketing, and other telephone businesses. The features of the new system are as follows: Low cost system construction compared with conventional systems, flexible platform availability, and packaged system software to provide various services other than the automatic voice answering function

* ***Future'z Co., Ltd.***
No.2 Yagi Bldg. 4F, 3-6-2, Shibuya, Shibuya-ku, Tokyo 150-0002
Tel: +81-3-5468-3421
Fax: +81-3-5468-3422

Process & Production Engineering

98-06-005-01
High-Functional Industrial Plant Monitoring System

Nissin Systems Co., Ltd. has started marketing a newly developed NeoPDL.V2 mini, a newly developed lower priced, compact version of its existing high-functional industrial plant monitoring and control system NeoPDL.V2.

NeoPDL.V2mini features ease of operation and is equipped with a table form display screen, by which system monitoring of various facilities for keeping track of the power supply and consumption state, the state of supply of service and sewage water as well as the state of combustion, can be monitored with various types of instruments for integrated and distributed monitoring and control, and the results edited and printed out. The system introduces the display of the monitored results on a table type display device.

With conventional systems, it had been necessary to engage in design and fabrication in conformance with the user working environment, so it had been necessary for workers to get to the site to make system adjustments. NeoPDL.V2mini has been standardized and does not require any adjustments at the site, and is usable whenever necessary.

With conventional systems, it had been difficult for the user to set or change related information such as the names of the equipment or the display scale, but the new system now enables information in connection with the equipment name or display scale to be set or altered flexibly.

The new system incorporates the company's unique data recovery function. Whenever some problem occurs with the personal computer engaged in system data control, or when some unforeseen irregularity such as a communications irregularity between the personal computer and sequencer occurs to make proper data recording impossible, this function enables retrieval, recording and alteration of data accumulated in the sequencer. A maximum of data for the past two days can be stored, recorded and corrected with ease.

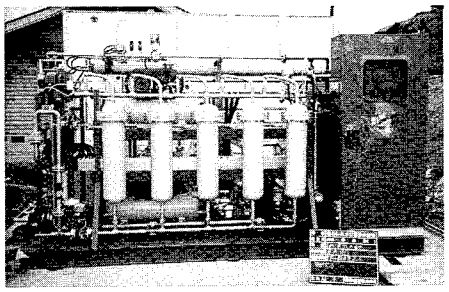
The main system functions may be summarized as follows: Monitoring function (table form) (preparation of graphic display optional), Message listing function, Ledger control function, System maintenance function, Tel/Fax communications function (optional), Alarm listing function, Trend graph display function, Power demand monitoring function (optional).

* ***Nissin Systems Co., Ltd.***
Public Relations Dept.
293-1, Ayahorikawa-cho, Horikawa-dori, Ayano-koji Sagaru, Shimogyo-ku, Kyoto City, Kyoto 600-8482
Tel: +81-75-344-7892
Fax: +81-75-344-7887
URL: http://www.co-nss.co.jp
E-mail: webmaster@co-nss.co.jp

98-06-005-02
Drinking Water Preparation System for Working with All Types of Water Sources

Yanagida Industries Corp. has started marketing a drinking water preparation system that is operable continuously around the clock for at least 50% of its full capacity even when the system is being inspected since it consists of two systems.

The system enables drinking water to be produced from all kinds of source water from seawater to muddy water simply by applying pressure on the source water and passing the water through a reverse osmosis membrane system. The use of the reverse osmosis membrane has the effect of removing all kinds of harmful substances such as E. coli, bacteria in general, salinity, floating particles and agricultural chemicals. More recently, the system has been confirmed to remove the bacterium cryptosporidium that cannot be sterilized even with chlorine. The system is also equipped with a pretreatment mechanism to treat algae to permit the source water to be used as agricultural water.



Drinking water preparation system for working with all types of water sources

The system is operable with a generator at places where commercial power is unavailable, and is designed compact to permit its conveyance with a general-purpose truck. The system is available in a series of models for a daily water supply from 20 t to 160 t, and the system is sold at a domestic price of about ¥18 million depending on its specifications. The first system has been put into operation at the Awaji Hanasajiki Water Purification Center in Higashiura Town, Hyogo Prefecture.

* ***Yanagida Industries Corporation***
Industrial Machinary Engineering Dept.
2-6-20, Chidori, Arai-cho, Takasago City, Hyogo Pref. 676-0004
Tel: +81-794-42-1521
Fax: +81-794-43-0637

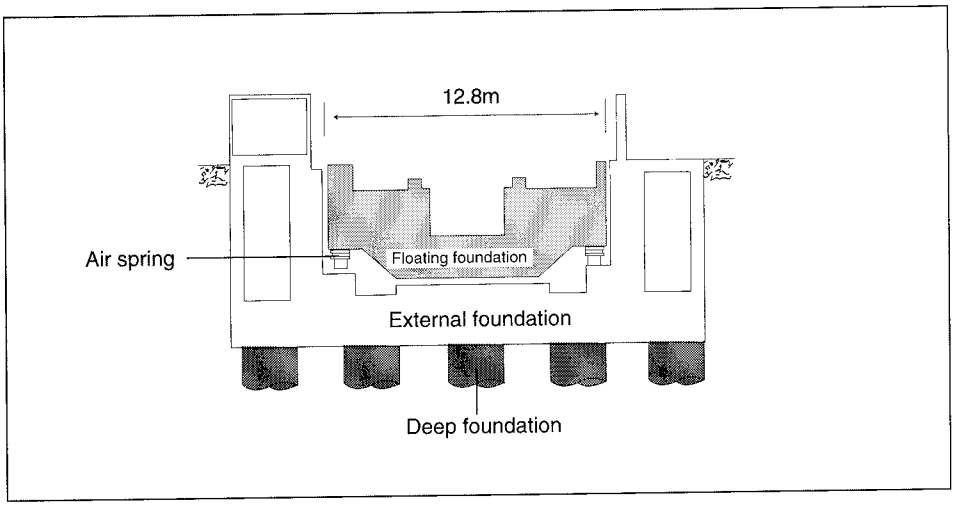
Construction & Transportation

98-06-006-01
Vibration Isolation System Using Air Springs

Kajima Corp. has developed a vibration isolation system for use at large experimental facilities or in factories generating many vibrations. The foundation part of a building is separated into an external foundation unit in the ground and a floating foundation that is supported with air springs. The system has a structure resembling that of a quakeproof structure.

At the experimental facility where the vibration damping system was applied, comparisons prior to and after the system was installed confirmed that there was a vibration reduction effect of about 30 dB (effect of reducing the vibration to one-thirtieth).

Small size vibration isolation systems using air springs had been already available,



Application example

but when working with super large facilities with a floating foundation weighing as much as several thousand tons, it had been difficult to design and construct and adjust the air springs for the entire facility, so the air spring has not been used up till now. The company installed this vibration isolation system for a shaking table foundation with 110 large air springs and 256 units of oil dampers to support a floating foundation weighing as much as 4,600 t, and repeated performance experiments.

Comparison of results between with and without (air in air springs is released, and the floating foundation is settled directly on the external foundation) the system showed that the vibration propagation level to circumferential ground can be reduced to about one-thirtieth. Compared with similar structures using vibration-damping rubber, the new system features a better flexibility and more excellent vibration shielding effect. The system enables the air springs to be changed to compatible vibration frequencies to those caused by machinery renovation or changes.

* ***Kajima Corporation***
Public Relations Office
1-2-7, Motoakasaka, Minato-ku, Tokyo
107-8388
Tel: +81-3-3404-3311
Fax: +81-3-5474-9497

98-06-006-02 Overhead Travelling Crane with Safety Device

Ryusei Kiko Co., Ltd. has developed an overhead travelling crane with a safety device by utilizing an open patent belonging to Matsuda Co., Ltd. This particular overhead travelling crane with the safety device prevents any inadvertent collision between cranes when several units are used on the same rail system, and therefore expands the working ranges of travelling cranes.

Up till now, sensors such as photoelectric tubes had been installed to sense any approach of cranes within some prescribed distance to prevent collision, but this method had been problematical in that the crane travelling domain is limited to aggravate the working efficiency. The new overhead travelling crane system eliminates these inconveniences and provides safety against collisions when operating multiple cranes on a single running rail system by using a safety device that expands the domain of crane travel.

The newly devised crane system resolves problems by using a crane travel safety device that enables safe crane travel when multiple cranes, each equipped with a retaining unit for retaining the conveyance cargoes in position, are run on the travel rail in the same direction. A safety device is mounted on each of the cranes to sense that these cranes are maintaining the prescribed spacing. At the same time, multiple strikers are arranged at multiple equally sectionalized positions and having the same spacing as the sensor range in the lengthwise direction of the running rails. Also, sensor switches to sense the strikers concerned are provided on the cranes.

The crane detection switches corresponding to the detection signals output by the crane detection switches are actuated, and whenever the sensing unit concerned outputs a sensing signal, the adjacent cranes are stopped or a crane drive control system operates to provide an adequate spacing between the adjacent cranes.

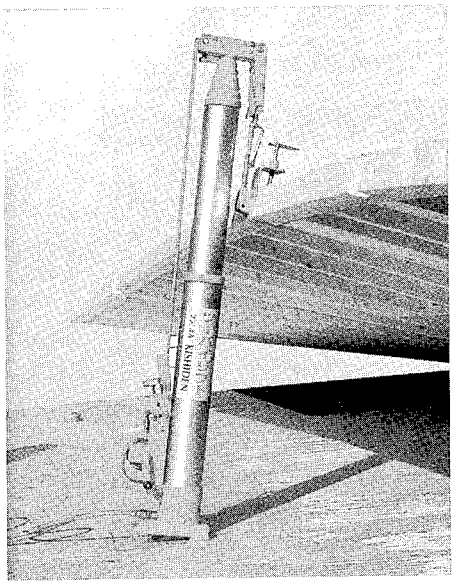
* ***Ryusei Kiko Co., Ltd.***
1-351-55, 6 Jyo, Nishimiyanosawa, Teine-ku, Sapporo City, Hokkaido
006-0006
Tel: +81-11-694-0861
Fax: +81-11-694-0861

98-06-006-03 Highly Efficient Panel Erection System

Kishiden Kogyo Co., Ltd. has developed a Two-by Lift for working with two-by-four (2 × 4) panels in construction projects. The new lift system is marketed through construction and metallic materials wholesalers throughout the country at a domestic price of ¥ 300,000.

Using this lift system enables the work previously requiring 3-5 workers for erection in about 30 minutes to be accomplished by a single worker with a remote control switch and an air compressor (of least 1 horse power) in about 9 minutes, which translates into considerable work efficiency improvement and rationalization. This lift system enables panels with widths of 15 m and 2.7 m tall to be lifted, lowered and positions adjusted rapidly with a remote control switch that is handled with ease.

The system consists of seven aluminum cylinders with a thickness of 3 mm, and



Panel erection system

since the system weighs only 22 kg, it can be moved about with ease for conveyance to worksites with a single worker. The body is 170 mm wide, 300 mm deep, 930 mm tall, and can be lifted by a worker with a single hand for loading onto a small truck for convenience to worksites with ease.

The panels are held securely with a clamp (inside dimensions 160 mm for working with panels of up to a thickness of 90 mm). The balance of the erected panels is maintained with a tension belt, so operations can be performed with great safety.

* ***Kishiden Kogyo Co., Ltd.***
Public Relations Dept.
7-18-29, Iriya, Adachi-ku, Tokyo 121-0836
Fax: +81-3-3899-6882

98-06-006-04

Vibration Damping System Using Ball Screws and Viscous Fluid

Sumitomo Construction Co., Ltd., with the cooperation of THK Co., Ltd., has developed a new type of vibration damping system called Damping Gyro. The building deformation caused by vibrations is converted into a rotary motion with screws, the motion accelerated by adjusting the size of the rotary unit radius, while the rotary unit is longer and its area of contact with a viscous fluid increased to obtain an effective vibration damping force.

The ball screws have a structure in which ball bearings are rolled inside the contact part, so the coefficient of friction is extremely low. The ball screws are designed to make one revolution per pitch, and the rotary unit is mounted so that the screw and the axial line are matched perfectly. When a force is impressed on this system in the axial direction, a slight motion is converted into a large motion at the tip of the rotary unit. The viscous resistance becomes proportionally large in concert with the target object moving inside the viscous medium, so the rotary unit enclosed in the viscous fluid generates an enormous attenuation force. The Damping Gyro is based on this principle, and generates an enormous damping force despite its small size.

The attenuation top is available in the cylinder type and the disk type. With the cylinder type, the rotary body is cylindrical and enclosed in a viscous fluid. The vibration damping force is adjusted with the screw pitch, the length and diameter of the rotary unit, and the viscosity of the viscous fluid. Meanwhile, with the disk type, the rotary body is of disk form and enclosed in a viscous fluid, and the vibration damping force adjusted with the screw pitch, disk diameter and the viscous fluid viscosity. These Damping Gyros, although miniature, can be applied to damping relatively small local vibrations to the damping of building vibrations caused by earthquakes (attenuation force of several hundred tons). In addition, by installing the damping system in brace form in building structures, the system can be used to suppress the inter strata displacements of buildings, and by installing the damping system in the upper and lower floor of buildings, it will become possible to apply the system for the local attenuation of relatively small vibrations. The damping system may also be installed on peripheral columns of superhigh-rise buildings or tower-like structures to dampen flexural deformation. The damping system is marketed at a domestic price of ¥15,000-20,000 per ton maximum damping force.

* ***Sumitomo Construction Co., Ltd.***
Public Relations Dept.
13-4, Araki-cho, Shinjuku-ku, Tokyo 160-8577
Tel: +81-3-3225-5101
Fax: +81-3-3356-8402

Energy & Resources

98-06-007-01

Mass Production of Large-Capacity, Low-Priced Nickel-Based Cathode Material for Lithium Ion Secondary Batteries

Toray Industries, Inc. and Honjo FMC Energy Systems Inc. have jointly established a technology for the mass production of a large-capacity, low-priced nickel-based cathode material for producing lithium ion secondary batteries. The market demand for lithium ion secondary batteries is increasing at a fast pace for use in portable telephone units and notebook type personal computers, and Honjo FMC Energy Systems plans to manufacture and sell the cathode material for use by leading battery manufacturers.

The nickel-based cathode material that enables batteries of larger capacities to be produced than cobalt-based materials had been attracting attention, but material use had been obstructed by problems such as battery capacity being deteriorated with repeated charging and discharging, and the difficulty of machining the material into electrode form.

Toray Industries, when synthesizing $LiNi_{1-x}Co_xO_2$ by substituting a part of nickel lithium oxide with cobalt, perceived that the addition of a small amount of alkaline earth metal element, especially strontium, would be quite effective for improving both the battery performance and the battery productivity. The two companies applied this technology, jointly established mass production technology, and succeeded in developing the new product.

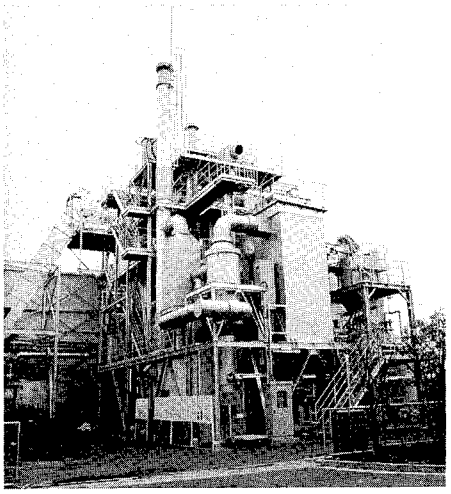
The newly developed nickel-based cathode material features a large discharge capacity (185 mAh/g) and excellent high power density cycling characteristic (capacity retention of 98-100% with 100 cycles), and the electrode paste resists gelling and displays a long pot life.

* ***Honjo FMC Energy Systems Inc.***
Public Relations Dept.
5-24, Miyahara 3-chome, Yodogawa-ku,
Osaka City, Osaka 532-0003
Tel: +81-6-399-2951
Fax: +81-6-399-2345
E-mail : nomiyama@honjo-fmc.co.jp

98-06-007-02

Fluidized Bed Gasification & Melting System

Ebara Corp. has commenced demonstration operation of a refuse incineration fluidized bed gasification and melting furnace installed at its Fujisawa Plant (Fujisawa City) that uses a heat exchanger made of ceramics with steam conditions are set at a high level of 100 kg/cm^2 and 500 ° C to realize a power generation efficiency of 30%, the highest level for a refuse incineration power generation sys-



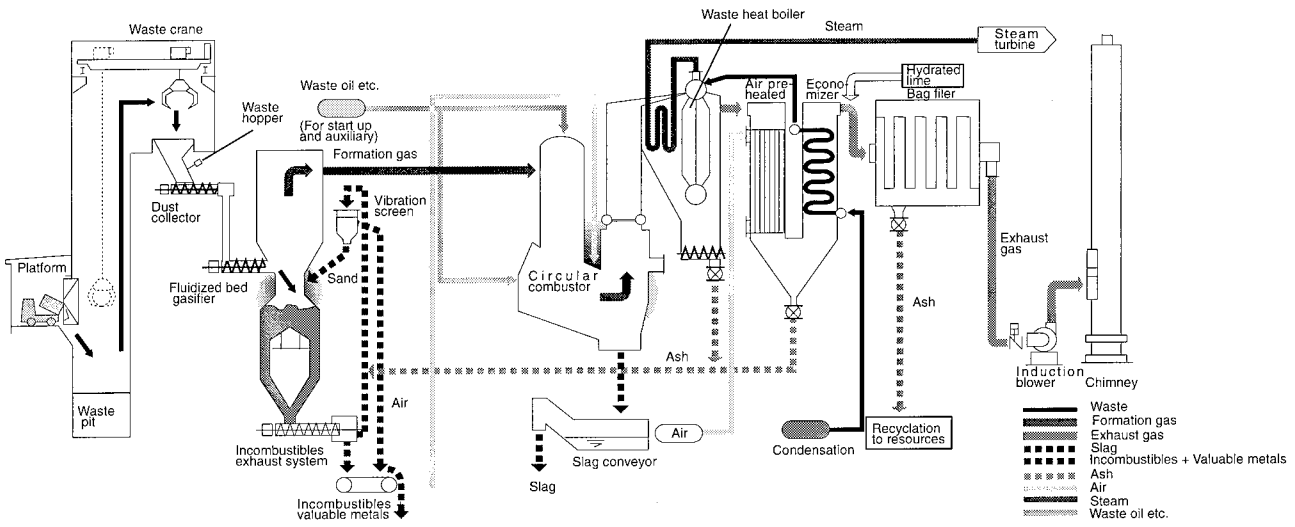
Fluidized bed gasification and melting furnace

tem. Heat exchange of the combustion gas is accomplished outside, so that the heat recovery tubes are not corroded, and power generation at a high efficiency is possible.

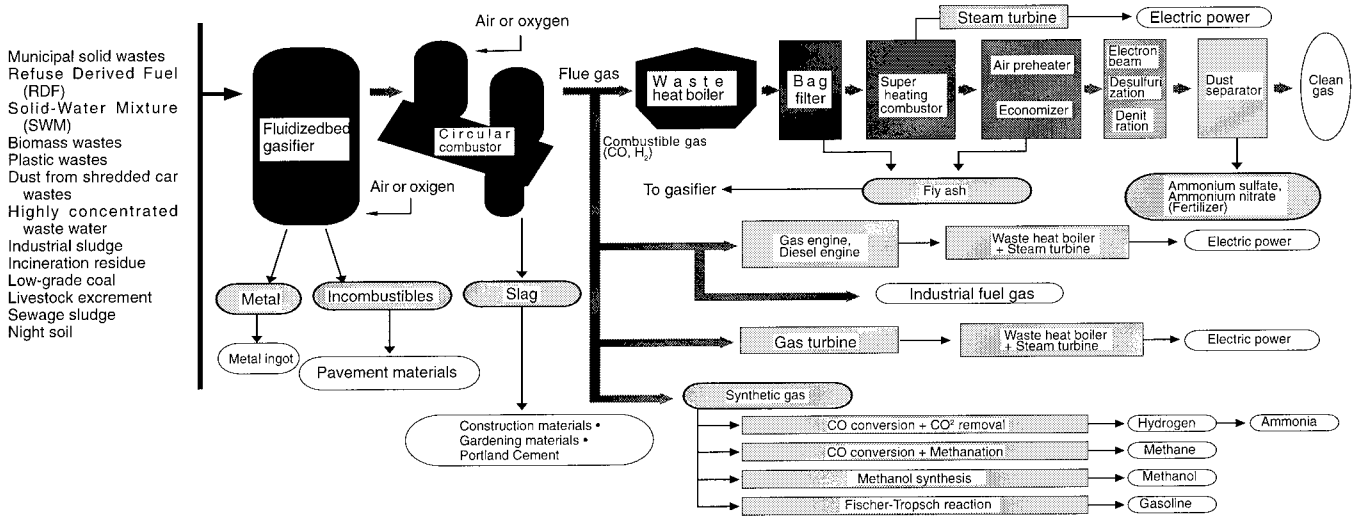
This demonstration furnace has a refuse treatment capacity of 20 t/day, and experiments conducted earlier have already corroborated that the dioxin concentration in the combustion gas discharged from the melting furnace is as low as 0.6 ng/Nm^3 TEQ, and that when the gas is passed through a bag filter, it is further reduced to 0.02 ng/Nm^3 TEQ. With the aim of decreasing the dioxin concentration further to 0.01 ng/Nm^3 TEQ and to utilize the combustion gas energy for high-efficiency power generation, necessary facility revisions were made and the fluidized bed refuse gasification and melting system entered demonstration operation.

To attain a power generation efficiency of 30%, the heat exchanger made of ceramics was placed in a position different from that of conventional systems. Normally, the heat exchanger is positioned directly near the combustion gas source, so when the steam temperature is raised to over 400 ° C to raise the power generation efficiency, the heat recovery tubes are corroded rapidly and the lack of durability had been a serious problem.

The heat exchanger was positioned outside the combustion gas domain and the steam conditions raised to 400 ° C and 100



System flow



Zero emission system adopting fluidized-bed gasification and combustion technology

kg/cm^2, by which the power generation efficiency is raised to 30% by performing steam heat exchange outside the combustion gas source and superheating the steam to 500 ° C.

The furnace adopts the method of partial combustion at an air ratio of 0.1-0.3, so refuse of three times the normal volume can be fed inside compared with conventional types of furnaces, making the furnace quite compact. Further, the zero emission system applied to this technology produces no secondary pollution, and enhances the efficiency of material, thermal and chemical recycling. This new system can be used to produce electric power, chemical industrial materials, metals, slag and other useful substances. In addition, the furnace enables total treatment of various types of wastes, the high-temperature combustion prevents the generation of secondary pollution by heavy metals or dioxin, and recycling of useful substances is possible at a high efficiency in addition to dioxin decomposition and ash melting, so the system total running cost is reduced substantially.

* ***Ebara Corporation***
Public Relations Dept.
11-1, Asahi-cho, Haneda, Ota-ku, Tokyo 144-8510
Tel: + 81-3-3743-6161
Fax: +81-3-3743-6589

Environment

98-06-008-01

Degradation of Dioxin by White Rot Fungus

A research team consisting of technical personnel belonging to the Fukuoka Institute of Health and Environmental Sciences and the Faculty of Agriculture, Kyushu University, has confirmed that as many as 136 types of dioxins generated by municipal waste incinerators are degraded by action of a white rot fungus, an organism belonging to the mushroom family.

The main white rot fungus belongs to the basidiomycetes and is known to consist of 1,600-1700 strains. A well studied strain is *Phanerocheate chrysosporium*, which was confirmed to degrade a wide spectrum of recalcitrant organopollutants, such as DDT, lindane, polycyclic aromatic hydrocarbons (benzo (a)pyrene , fluorene, etc.) , chlorophenols, polychlorinated biphenyls, TNT (trinitrotoluene) and azo dyes.

The distinct characteristic of the white rot fungus is that it degrades an extremely wide range from low-molecular to polymer chemical compounds and very toxic environmental pollutants without being influenced by the target substance chemical structure. Another special distinct feature of the white rot fungus is to degrade the wide range of pollutants to carbon dioxide.

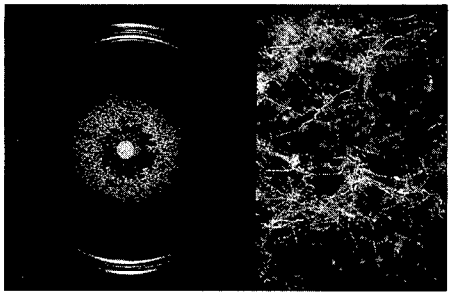
In the early study, degradation of the white rot fungus *Phanerochaete sordida* YK-624 isolated in the laboratory was performed on a mixture of 10 kinds of the 2-, 3-, 7- ,8- substituted tetra- through octa- chlorodibenzo-p-dioxins (polychlorinated dibenzo-p-dioxin : PCDDs) and chlorodibenzofurans (polychlorinated dibenzofurans: PCDFs), which include the most toxic compounds among PCDDs and PCDFs congeners. The percentage degradation of PCDDs and PCDFs was approximately 40 (tetrachloro-) to 76% (hexachloro), and 45 (tetrachloro)% to 70% (hexachloro-), respectively. It was also verified that metabolites are produced by the fungus from both 2,3,7,8-tetraCDD and octaCDD. The degradation of above 10 kinds of dioxins by *P.chrysosporium* was also carried out and the results show almost the same degradation as *P.sordida.*

Then was investigated that the extent of degradability of a number of PCDD and PCDF congeners containing 4 to 8 chlorine atoms extracted from a fly ash sample by the white rot fungus *P.sordida.*

All congeners of PCDDs and PCDFs (136 compounds) were apparently confirmed to be degraded by the fungus and no obvious differences to the number and the position of chlorine substituents of the molecules were obtained. The percentage degradations in total amount of all isomers of each PCDD and PCDF homologue were from 49% (tetra CDDs) to 67% (hepta CDDs) and from 51% (tetra CDDs) to 74% (octaCDD), respectively.

Consequently, the white rot fungus was found to be a promising microorganism possessing remarkable biodegradative properties for all PCDDs and PCDFs.

* ***Fukuoka Institute of Health and Environmental Sciences***
39 Mukaizano, Dazaifu, Fukuoka Pref. 818-0135
Tel: +81-92-921-9944
Fax: +81-92-928-1203



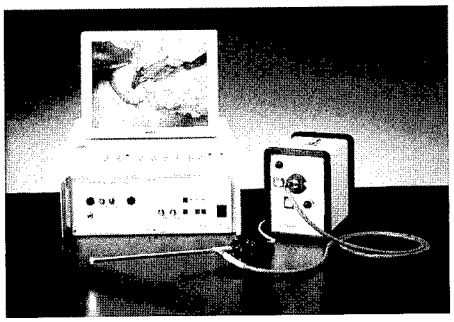
Phanerocheate chrysosporium

Biotechnology & Medical Science

98-06-009-01

Monitoring System Using Stereoscopic Endoscope

Sanyo Electric Co., Ltd. and Shinko Optical Co., Ltd. have jointly developed a monitoring system using a stereoscopic endoscope which provides stereoscopic images without having to wear special-purpose spectacles. The monitoring system will be placed on the market this coming August. This marks the first development of a stereoscopic endoscope requiring no special-purpose spectacles, and the company anticipates that this endoscope will



Monitoring system using a stereoscopic endoscope which provides stereoscopic images

come into wide use in the sector of cranial nerve surgery and cardiosurgery.

Minimally invasive surgery is expected to attract great attention in the sector of medical therapy as a method that minimizes surgical invasion into the patient body, by which the hospitalization period and recovery period are both shortened, and patient pain is also minimized. However, today, most surgical operations are performed by observing the progress of surgery on a TV monitor using a single endoscope, so that there is a lack of the sense of depth and difficulty is encountered when conducting operations in complex anatomy. A system has been developed to use a pair of endoscopes relying on stereoscopic images, but a special type of spectacles has to be used, which involves the problem of eye fatigue and is preventing the system application to surgeries extending over long periods of time.

The two companies directed attention on the problems involved and conducted separate research from the aspects of the endoscope and the monitor, and succeeded in establishing a monitoring system using a stereoscopic endoscope that requires no spectacles, which resolves the problems associated with the conventional MIS method.

The camera used with the new system mounts three one-third interline transfer system charge-coupled devices (CCDs) of about 410,000 pixels, and the 3D display is a double image splitter. The stereoscopic display system is marketed at a domestic price of ¥22 million, but the price of the stereoscopic endoscope system is as yet undecided.

* ***Sanyo Electric Co., Ltd.***
LCD Visual Sales Dept.
1-1, Sanyo-cho, Daito City, Osaka 574-8534
Tel: +81-720-70-6132
Fax: +81-720-70-6069

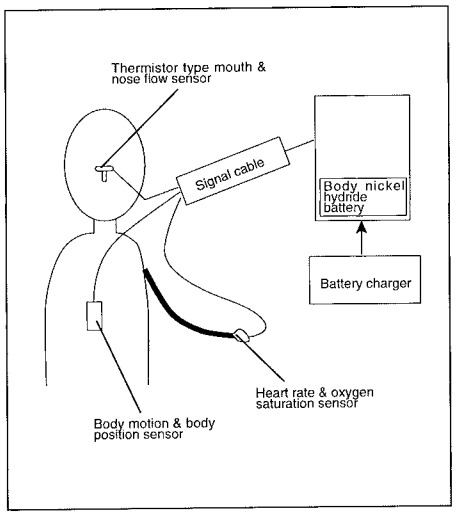
98-06-009-02

Monitoring System for Home Oxygen Therapy

Chest M.I.Inc., a manufacturer of respiratory medical equipment, has developed jointly with Tohoku Electronic Industrial Co., Ltd. (Sendai City) and Cosmos Co., Ltd. (Sendai City) a patient monitoring system for home oxygen therapy. The system keeps around-the-clock records of COPD (chronic obstructive pulmonary disease) receiving oxygen inhalation treatment at home. All information and data and store are analyzed by a personal computer for use in diagnosis and therapy.

This monitoring system is called Hot Mate compactness. Consists of a portable main unit (116 mm long, 31 mm deep, 150 mm tall and weighing 350 g with battery), and features 24 hour memory function a heart rate & oxygen saturation sensor, a body motion & body position sensor, and a thermistor type mouth & nose flow sensor.

The system is compact, lightweight and functions with easy operation. The sensors are fitted snugly on the patient body with adhesive tape, and various measurements are performed continuously in daily life and stored in the memory, such as the arterial oxygen saturation, respiration, heart rate, body position and body motions around the clock. These data are downloaded to the host computer in the hospital for further analysis. Detailed individual patient data can be obtained which are highly beneficial to the advancement of oxygen therapy, diagnosis and treatment.



Block diagram

As for the principle of operation of the monitoring system, patient respiration is detected by the thermistor respiratory flow sensor. A nose and mouth sensor with thermistors in the nostril and on the lips is used to distinguish patient inhalation and exhalation by detecting difference in temperature. The respiratory condition is displayed on the LCD of the main unit. A pulse oximeter detects and records the heartrate arterial and the degree of oxygen saturation. The values are displayed digitally on the LCD and the results are displayed digitally on the screen. Simultaneously, the state of blood flow is monitored with a bar indication system on the LCD.

As for the body motion sensor, a monolithic chip IC sensor is used to measure the sensor electrostatic capacitance at changes by acceleration. The intensity and frequency are detected by the obtained signal and recorded. The body position sensor contains a mercury switch that is ON and OFF depending on the angle, and the duration of time and the state are recorded each time the sensor angle is changed. At present, one large sensor is used to detect only the patient sleeping and awakening, but in the future plan, several sensors will be used to distinguish the patient sleeping position.

In Japan, about 60,000 patients are under home oxygen therapy, mostly elderly persons, due to respiratory difficulties caused by pulmonary emphysema, asthma and lung cancer. The number is certain to increase in the years ahead because of the oncoming aged society, so the development of home oxygen therapy support equipment is an urgent need.

This is the first unit which has been developed to allow monitoring of home oxygen therapy patients around the clock. The system is presently being used experimentally by the Faculty of Medical Science of Tohoku University . Currently a patient has to bring the main unit to the hospital to download the data. However, further research is in progress for remote access from the PC in the hospital to receive the data by modem and also control the unit.

* ***Chest M.I.Inc.***
Public Relations Dept.
3-6-10, Hongo, Bunkyo-ku, Tokyo 113-0033
Tel: +81-3-3812-7251
Fax: +81-3-3812-7220

JETRO

Japan External Trade Organization

Machinery and Technology Department